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ASPECTS OF COGNITIVE COMPLEXITY THEORY AND RESEARCH

AS APPLIED TO A MANAGERIAL DECISION MAKING SIMULATION

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ASPECTS OF COGNITIVE COMPLEXITY THEORY AND RESEARCH AS APPLIED TO A MANAGERIAL DECISION MAKING SIMULATION

BRIEF

Requirement:

There is a widely recognized need to provide top level Army managers with better information and with tools to better utilize the information they have. This need exists, not only within battle situations, but also within strategic and managerial situations. Top level decision making is typically characterized by lack of complete information, multiple and conflicting objectives, high levels of uncertainty, turbulent environments, and decision outcomes that tend to be both costly and long range in their implications. There is a substantial body of literature which suggests that many managers respond to turbulent environments in a manner different from that which is predicted to lead to greater effectiveness.

This report establishes cognitive complexity theory as the basis for a man-machine managerial assessment and training vehicle, employing computer-based technology, that simulates complex information processing and decision making requirements within a senior-level military management context. This vehicle is termed the Management Assessment and Training Simulation System. Participants' performance will be assessed using problem scenarios, and the results of these embedded assessments will be fed back to participants. This feedback is intended to help participants to better integrate and differentiate complex information.

Procedure:

A literature review in the area of cognitive complexity is presented. The review is organized into three basic sections, addressing in turn, theory, research, and measurement. Within each of these sections, pre-1977 work is treated in an overview fashion, and more detailed reviews of post-1977 studies are then presented. This review updates the previous major review in this area (i.e., Streufert and Streufert, 1978).

Findings:

Based upon the review, a measurement strategy for assessing the decision style utilized by participants in the Management Assessment and Training Simulation System is identified. This approach includes ten categories of measures which, together, are intended to provide a wide range of insight into a person's, group's, or organization's style of decision making. Further, several potential approaches for use as

additional (outside) measures in the Management Assessment and Training Simulation System are discussed. These include measures based upon the theoretical work of Elliott Jaques, as well as measures of simultaneous information processing ability and of psychological load.

Utilization of Findings:

Measures identified as a result of the cognitive complexity literature reviewed in this document are prime candidates for inclusion in the development of a mini-computer-based Management Assessment and Training Simulation System. The overall purposes of this system are

(1) to help managers better process information in complex, turbulent environments, and

(2) to help managers better structure their organizations so that human decision makers can appropriately process information received.

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I. INTRODUCTION

This document is the sixth in a series which report on research conducted by the Behavioral Sciences Research Center at Science Applications, Inc., under Contract No. MDA 903-79-C-0699 with the U.S. Army Research Institute for the Behavioral and Social Sciences. Other documents in the series include:

Baudhuin, E. S., Swezey, R. W., Foster, G. D. and Streufert, S. An empirically derived taxonomy of organizational systems. (SAI Report No. SAI-80-091-178) McLean, VA: Science Applications, Inc., 1980.

Davis, E. G., Foster, G. D., Kirchner-Dean, E. and Swezey, R. W. An annotated bibliography of literature integrating organizational and systems theory. (SAI Report No. SAI-80-082-178) McLean, VA: Science Applications, Inc., 1980.

Streufert, S. and Swezey, R. W. Organizational simulation: Theoretical aspects of test bed design. (SAI Report No. SAI-80-010-178) McLean, VA: Science Applications, Inc., 1980.

Swezey, R. W., Davis, E. G., Baudhuin, E. S., Streufert, S. and Evans, R. A. Organizational and systems theories: An integrated review. (SAI Report No. SAI-80-113-178) McLean, VA: Science Applications, Inc., 1980.

Atwood, M. A. and Swezey, R. W. Microprocessor considerations for a management assessment and training simulation system. (SAI Technical Memorandum 178-81-1) McLean, VA: Science Applications, Inc., 1981.

This report provides a discussion of the overall area of cognitive complexity theory, research, and measurement as it applies to the development of a computer-based Management Assessment and Training Simulation System. There is a widely recognized need to provide top

level Army managers with better information and with tools to better utilize the information they have. This need exists not only within battle situations, but also within strategic and managerial situations. Top level decision making is typically characterized by lack of complete information, multiple and conflicting objectives, high levels of uncertainty, turbulent environments, and decision outcomes that tend to be both costly and long-range in their implications. There is a substantial body of literature which suggests that many managers respond to turbulent environments in a manner different from that which is predicted to lead to greater effectiveness.

This effort establishes a man-machine managerial assessment and training vehicle, employing computer-based technology, that simulates complex information processing and decision making requirements within a senior level military management context. Participants' performance will be assessed using problem scenarios and the results of these embedded assessments will be fed back to participants. This feedback is intended to help participants to better integrate and differentiate complex information.

Research already performed under this contract has established theoretical and methodological bases for the development of such a simulation system. The system will allow for manipulation of management action to permit training procedures to aid in improving decision making performance, and to provide diagnostic tools for managers. The framework established for the simulation is found in two reports:

1. Literature Review (Swezey et al., 1980). This document represents a review of current (post 1960) experimental and theoretical research on characteristics, processes and dimensions which are relevant to the objectives of this effort. It was based upon a factor analytically generated taxonomy of variables. The most relevant factor, multidimensional information processing, reflects individual and organizational processes in open systems. It is concerned with information input into the system, the perception

of that input, its classification and organization, its differentiation and integration through the structure of the organization, and the resulting output.

2. Simulation Specification (Streufert and Swezey, 1980). This report deals with the characteristics of the simulation from a theoretical perspective. It discusses various types of procedures which are available for simulation construction and the reasoning behind choices made to achieve specific goals. The report specifies how the simulation, type of military unit, and setting selected may be utilized to achieve the following purposes:

- utilization of the simulation for training purposes, including the matching of variable characteristics to specific training needs of the organizations under consideration, and to the settings in which these organizations operate; and

- utilization of the simulation as a potential diagnostic assessment module for managers.

II. COGNITIVE COMPLEXITY: THEORY, RESEARCH, MEASUREMENT

The last extensive review of cognitive complexity appeared as a chapter in a book by Streufert and Streufert (1978), covering theory and research up to the early months of the year 1977. Since that time, theory has been advanced by Scott, Osgood, and Peterson (1979) and by Streufert and Streufert (1978; c.f., Streufert, 1978) among others. In addition, about 300 research studies have been published in English, French, German, and Japanese, not even considering an approximately equal number of dissertations. Considerable new knowledge has been gained both in the theoretical and research realms. Lesser advances have been reported in measurement. This chapter will cover all three of these areas, beginning with a review of the conclusions reached by Streufert and Streufert (1978), and continuing with developments which have occurred since that time.

THEORY

A Short Review of Theory through 1977

Definitions

Before adequate communication about cognitive complexity is possible, a variety of terms must be defined. Unfortunately, the meaning of terms has at times varied from one writer to another, leading to some degree of confusion in the literature. The following terminology will be used in this paper (as used previously by Streufert and Streufert, 1978).

Dimension: A bipolar semantic scale in a person's cognitive semantic space. The scale may have as few as two points of discrimination among stimuli (i.e., the poles), or it may have many more. The scale represents an individual's grouping or ordering of those stimuli which have meaning in the semantic space defined by the endpoints of the scale. This last point may be elucidated by an example, similar to one used by Kelly (1955). If an individual has in his cognitive space a dimension (scale) of short-tall, the endpoints of that dimension have meaning to the stimuli man or building, but do not have meaning in relation to the stimulus weather.

Discrimination: The process of dividing (or the degree to which division has been accomplished) a cognitive bipolar semantic dimension into parts (subsections) for the placement of stimuli which have semantic relevance to the endpoints (poles) of that dimension. Discrimination is meaningful only to the degree that sharp distinctions can be made, i.e., to the degree that the distinctions can either be labeled or to the degree that they can evoke differential outcomes in behavior. The minimum number of discriminations on any dimension is two (pole A vs. not-pole A; or pole A vs. pole B). The maximum number of discriminations on any dimension is limited only by the capacity of the organism to meaningfully divide the semantic space of any dimension.

The process of discrimination, althouth unidimensional, is related to the processes of differentiation and integration (see below). As in differentiation, it involves the dividing of a segment of semantic space (here, of one dimension only); and as in integration, it involves the assembling of various semantic points (meaning) into a (here, unidimensional) subsegment of semantic space.

Differentiation: The process of dividing cognitive semantic space (or the degree to which this division has been achieved relevant to specific stimulus configurations) into two or more orthogonal or oblique (but near-orthogonal) bipolar semantic dimensions - i.e., the ordering of stimuli in intransitive fashion on two or more scales in semantic space.

Integration: The process of relating a stimulus configuration to two or more orthogonal or oblique dimensions of semantic space (or the degree to which this relating has been achieved) to produce a perceptual

or behavioral outcome which is determined by the joint (weighted or unweighted) demands of each dimension involved.

Hierarchical integration: The fixed, unchanging relationship among dimensions with regard to a number of stimulus configurations, producing a joint weighted or unweighted, but stable, response to stimuli. Specific stimuli would always affect the same dimensions in the same way.

Flexible integration: The varied, changing relationship among dimensions with regard to stimulus configurations, producing various diverse (over stimulus type, presence/absence, or frequency) weighted or unweighted, more or less unstable, responses to stimuli.

Content: Represents the location of any specific stimulus object or configuration on any specific discriminated point on a cognitive dimension to which it is assigned by the individual (e.g., an attitude). In other words, cognitive content is concerned with the relationship of various stimulus objects to each other on that dimension (as contrasted to the structural relationship among dimensions). Content represents what a person thinks about a stimulus, not how he thinks about it.

Structure: Represents the differentiative or integrative use of dimensions of semantic space with regard to a specific stimulus object or configuration. Structure is concerned with the number of dimensions and the number and pattern of relationships among them (i.e., the organization of cognitive semantic space), rather than the meaning of the specific dimensions involved. In other words, while content is concerned with what an individual thinks about a stimulus and what response he makes to it, structure is concerned with the cognitive processes underlying a response, i.e., how he thinks about the stimulus.

Cognitive complexity-simplicity: Represents the degree to which the entire and/or a subsegment of a cognitive semantic space is differentiated and integrated.

Theoretical Positions

The reader familiar with some of the complexity theories should be warned that he/she may notice that one theory or another appears modified in this chapter from what a reading of the original manuscripts might have suggested. Changes are due to changes in terminology, not changes in the content of the theories. By using the same terminology with regard to all of the complexity theories, all can be brought to a "common denominator" making meaningful comparison among the theoretical (and research) efforts possible. In the following paragraphs each of the several theories published through 1977 will be reviewed very briefly.

Kelly (1955) proposed a "Psychology of Personal Constructs." He viewed his work as a guide for psychotherapy and client-therapist interaction. His concept of personal constructs and the Role Concept Repertoire (REP) Test, while not intended as a complexity approach, have certainly been the basis for later theories in the area. Kelly's "construct" is a bipolar dimension which results from an individual's process of "construing or (cognitively) interpreting" events. Kelly has considered dimensions in terms of similarity and contrast: If two events or objects are viewed as similar and a third is viewed as dissimilar, a construct (dimension) emerges. Constructs are proposed to relate to each other in terms of ordinal hierarchical relationships, but these relationships may be limited to certain areas (domains). Location of objects or concepts within constructs may or may not be fixed. The views of Kelly seem most closely related to Streuferts' concept of differentiation (as defined previously), although the potential for some (minimal) discrimination and integration is provided. Distinctions between content and structure are not made.

The theories of Bieri (1961, 1966; Bieri et al., 1966) are based on the work of Kelly. As was the case with Kelly, Bieri's work has been concerned with the effect of an individual's cognitive orientation on the judgments he or she makes in response to environmental stimulation. Bieri views complexity as a structural characteristic describing the use of psychological dimensions. According to Bieri (1968), complexity is only concerned with social judgments and the individual's "social versatility" in responding to inputs from other persons. The degree of cognitive complexity is related to the number of dimensions available to an individual. The more dimensions that are present, the greater the degree of cognitive complexity. Bieri discusses differentiation both in terms of an individual's cognitive structure (the number of dimensions available to that person), and in terms of the social stimulus environment (the number of dimensions possessed by the stimulus). Social perception then, is an interaction between stimulus complexity and structural (person) complexity. Bieri also considers discrimination (called articulation by that author), i.e., the process of making discriminations within dimensions, and a third judgmental process (called discrimination by that author) which makes unique distinctions among stimuli.

All in all, the efforts by Bieri tend into the direction of the analytic rather than the synthetic. The theory describes how stimuli are separated into meaningful categories on the basis of dimensions or on the basis of the stimuli themselves. It should be noted that the theory (in contrast to the early work of Kelly) is, however, purely structural in orientation even though limited by its location within the perceptual-social domain.

The Categorizing Theory of Zajonc (1960) is concerned with the O in the S-O-R relationship. Zajonc proposes that, given a set of stimuli and a set of responses made to those stimuli, a determinate correspondence between the elements of both sets can be derived.

The value(s) of this correspondence are described as attributes which can be inferred from a person's responses to a given set of stimuli. The established stimulus set to response set relationship will determine the value of any relevant new stimulus to which a person is exposed. Numbers of available attributes reflect differentiation. Complexity reflects the degree to which classes of attributes in a given cognitive structure can be subdivided.

The terminology of Zajonc (for example, the use of the term dimension) is widely different from that of most other complexity theorists. The descriptors (formulas) for each of the terms employed are similarly different, allowing very little comparison with other efforts. One of the major values of this approach is the impetus it provided for the subsequent theoretical formulations of Scott (1969, 1979) and associates.

The early cognitive structure theory of Scott (1969) was not only based on the work of Zajonc (1960), but combined that approach with some of the earlier formulations of Lewin (1936) and Heider (1946). Earlier distinctions between personality content and structural characteristics are elaborated by Scott into an encompassing theory of structural characteristics which has considerable implications for social, personality, clinical, and to some extent, organizational psychology. The definitions of content and structure advanced by Zajonc are quite similar to those proposed here and in Streufert and Streufert (1978). Scott was one of the first theorists to emphasize that structural characteristics (e.g., differentiation) may be limited to specific cognitive domains. Scott describes dimensions and discriminations on dimensions (there called attributes)[1] as images (or concepts of objects) representing combinations of objects' characteristics as points in multidimensional space, dimensionality, differentiation (within cognitive domains), and integration.

The theory of Scott is extensive and complex. Again, the terminology does not match that of many other theoretical orientations. A summary provided by Streufert and Streufert (1978) probably provides an accurate discussion of the Scott theory from the present point of view (pp. 25-26).

> Any perception by a person based on the phenomenological world results in an image which represents a point on one or more dimensions (attributes) of cognitive space. Where, on any dimension, the image falls depends on the number of segments of the dimension (degree of articulation of the attribute). The number of independent dimensions (attributes) into which a person sorts information reflects the degree to which he differentiates the specific cognitive domain into which he has placed the perceived stimuli.
>
> It should be noted that Scott views both dimensionality and discrimination (in his terms, attributes and articulation) as parts of the differentiation concept. In this way he differs from other theorists (e.g., Driver & Streufert, 1966; Schroder, Driver & Streufert, 1967; Streufert, 1970) who view discrimination as a separate process.
>
> Scott's view of 'integration' also differs from that of other theorists who have been primarily concerned with that concept (e.g., Driver & Streufert, 1966; Harvey, Hunt, and Schroeder, 1961; Schroder et al., 1967; Streufert, 1970). While all writers would agree that integration refers to the manner in which images are related, Scott includes a much greater number of cognitive operations in his 'integration' concept. For example, if (to use one of his integrative processes) various attributes (dimensions) are highly correlated with integrative processes) various attributes (dimensions) are highly correlated with 'affective-evaluative consistency,' then this form of association would be viewed by other theorists as the absence of complexity. Integration theorists would argue that

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[1]For purposes of saving space, Scott's distinction between attributes and dimensions is not reported in this paper. For some more detail, see the discussion of Scott's recent theoretical statements below and the original sources.

integration must follow differentiation. The use of divergent verbal labels for what is otherwise known as the good-bad (evaluative) dimension would suggest to them that identity (unity) of these attributes has been learned, and that a differentiation process did not take place before the association was made. Alternatively, the structure which once was differentiated may have become resimplified through a process that may be called hierarchical (Streufert, 1970), as distinguished from what Schroder et al. (1967) called integration proper, and what Driver and Streufert (1966) and Streufert (1970) have discussed as flexible integration.

A final distinguishing characteristic of Scott's theory is his repeated emphasis (e.g., Peterson & Scott, 1974; Scott, 1963) on the limitations of complexity across cognitive domains (cf. also Cohen & Feldman, 1975). He questions the assumption of the existence of structural _types_, i.e., the description of a person as 'simple,' 'complex,' etc. He considers it to be probable that the number of persons who have consistent structural characteristics among many areas of their experience is quite small, and further suggests that such individuals may well be pathological. Scott states, however (personal communication, 1975), that the attempt to describe such types is of value if developed empirically, rather than on an _a priori_ basis. Recent evidence (Peterson & Scott, 1974; Scott, 1974) suggests the existence of at least a limited typography: Some degree of generality of cognitive style across domains was obtained. Which style is utilized in a particular situation appears to be dependent upon an interaction between the structural characteristics of the person and the characteristics of the situation.

Impression Formation has been an interest of several complexity theorists (e.g., Bieri, 1955). Generally, it is suggested that persons who are complex (if applicable to the theory within a relevant domain) should form more veridical impressions (Bieri, 1955) or should include information that may, on the surface, appear contradictory (Streufert and Driver, 1967), than persons whose perceptual capacity or style reflects greater unidimensionality. In other words, such persons should respond less to the primacy or recency orientation

suggested and/or obtained by researchers associated with Asch (1946; Anderson and Barrios, 1961; and Luchins, 1957, 1958). Crockett (1965) and associates have carried out an extensive research program on impression formation. Their theoretical conceptions of complexity are based on the primacy-recency paradigm. Crockett's work is primarily derived from the developmental psychology of Werner (1957). Differentiation and discrimination (articulation) are said to follow the developmental process, resulting in "increased interdependence of elements" through integration into a <u>hierarchically</u> organized system. Complexity implies a cognitive system which contains a larger number of elements <u>and</u> the greater integration of those elements into a hierarchical system of relationships. The relative number of constructs in a cognitive system defines the degree of cognitive differentiation.

Crockett's concept of differentiation has much in common with those of the authors discussed above. It should be noted, however, that his definition of integration is hierarchical, i.e., non-flexible in the sense considered by the Harvey et al. and the Schroder et al. and the Streufert and Streufert theories (see below). Crockett's work is to some degree concerned with the generality of cognitive complexity; in otherwords he does not assume that complexity is necessarily the same from one domain to another.

Harvey, Hunt and Schroder (1961) proposed their "Systems Theory" as a developmental descriptive approach to behavior at four diverse levels of cognition. The System 1 person was viewed as a "yea sayer," accepting the demands, mores, folkways, and fads of his or her source of training without much question. The System 2 person, in contrast, is considered to be a "nay sayer," rebelling against the imposition of authority, i.e., not accepting the simple good-bad orientation of established norms. At the developmental level of System 3, the person is able to view alternatives as acceptable, resulting in

greater tolerance and displaying somewhat of a "nice guy" image. The System 4 person not only views alternatives, but relates them structurally to superordinate concepts, goals, etc. The authors suggest that persons may develop through all stages to reach System 4 or may get arrested at any one stage or in a transition between stages. Development through the stages is seen as representing development toward initially greater differentiation and later greater integration. Harvey et al. use the term "concrete" to describe the Stage 1 and the term "abstract" to describe the Stage 4 person. Hunt (1966) has added a "sub 1" stage to describe the person who is less than unidimensional (the good-bad dimension of the Stage 1 person is replaced by an inclusion/exclusion principle. With this addition, Hunt has added a form of "discrimination" to the theoretical formulation by showing that discrimination does not exist in the "sub 1" stage.

While the theory of Harvey et al. does include <u>some</u> structural characteristics, it is clearly confounded with content: for example, Stage 1 suggests authoritarianism, Stage 2 implies rebellion, and Stage 3 often can represent an attitude of tolerance (rather than tolerance based on potential alternate dimensional interpretation). The theory tends to place "value" on the level to which a person advances: it is a "good thing" to be System 4 and a "bad thing" to be sub-1.

Early interactive complexity theory (Driver and Streufert, 1966; Schroder, Driver, and Streufert, 1967; Streufert and Driver, 1967; Schroder, 1971) and its later versions (e.g., Streufert, 1970) propose that effective cognitive complexity is not only a function of a person's structural dimensionality, but depends as well on current environmental conditions. The theory proposes (an earlier and a later modified version of) a family of inverted U-shaped curves relating environmental complexity (e.g., information load) to differentiative

and integrative performance. Different persons, representing different degrees of cognitive complexity would reach diverse levels of differentiative/integrative performance as long as environmental conditions are optimal. Lesser or no differences would be expected when the environment is greatly overloading (excessive environmental complexity in terms of load and/or other variables) or when the environment deprives the individual of needed input. A number of environmental variables are considered. The approach is entirely structural and deals with differentiation and integration separately, suggesting that the two may (particularly in terms of measurement) not covary at all times. It is assumed (Streufert, 1970) that integration is probably best based on a moderate amount of (non-excessive) differentiation. The interactive complexity theory, as its name suggests, is the only one of the earlier complexity theories which specifically deals with environmental (stimulus) effects as equally important in relation to structural person variables. In addition, it moves clearly away from the interpersonal domain and explores complexity effects in other (e.g., non-social, decision making, etc.) domains as well.

Recent Advances in Complexity Theory

Two recent books are widely concerned with complexity theory. One is a volume by Scott, Osgood and Peterson (1979) which expands upon the earlier work of Scott. The other is a book by Streufert and Streufert (1978) which revises interactive complexity theory and adds a host of predictions about the effects of cognitive complexity and environmental complexity on a number of behaviors.

Streufert and Streufert (1978) developed their theoretical views on the basis of the interactive theories of Schroder, Driver, and Streufert (1967) and the more than fifty research manuscripts published by that research group in the period between 1967 and 1977. In addition, the complexity theory advanced by Streufert and Streufert

was specifically extended to decision making (Streufert, 1978) and to environmental problems (Streufert, Nogami, and Streufert, 1980). The theory views effective dimensionality (as did Schroder et al.. 1967) as a joint effect of individual (group and, potentially, organizational) differences in information processing structure and of the characteristics of the current environment in which an individual (group or organization) must function. A number of information processing characteristics are proposed with a series of associated measures. Differential predictions for differing environmental conditions and for individual (group or organizational) differences are advanced. For example, a family of inverted U-shaped curves relating environmental complexity to strategic performance is proposed. The different levels of that curve represent diverse differentiative/integrative capacity. The curves differ from those proposed by Schroder, Driver, and Streufert (1967) by a conceptualization of a common optimal level on the environmental complexity (for example information load) dimension for both more and less complex persons. The older theory had assumed that more complex persons would perform optimally at a higher level of environmental complexity.

The major advance of the Streufert and Streufert formulations are found in their examination of a number of other kinds of performance beyond the strategic (or planning) behaviors expected from more multidimensional decision makers or decision making groups. The theory considers the appropriateness of specific levels of a variety of behaviors (performance) with regard to particular task or environment demands and advances more than 100 predictions relating cognitive structure to various fields within personality, social, and organizational psychology. Because of the rather large number of hypotheses and proposition generated, a review of such detail would go far beyond the scope of this paper. The interested reader is refered to the original source documents.

In their most recent book, Scott and associates (Scott, Osgood and Peterson, 1979) maintain a Zajonc based approach to complexity, but refine and clarify their conceptualizations of cognitive structure, in general, and cognitive complexity (as used in this paper), in specific. The authors continue Scott's emphasis on cognitive domains and describe complexity in domain specific terms. The description is based on a geometric model of multidimensional space founded on euclidian geometry. Objects (conceptual or perceptual) are defined by their projections into dimensions (called attributes by Scott). Two objects, projected onto identical discriminated segments of all dimensions to which they are assigned, are indistinguishable, even if they have different names. Correspondingly, two dimensions which order or classify all objects in the same way are also indistinguishable and considered identical.

The geometric model measures the similarity or the degree of distinctiveness of two cognitive domains. If, for example, a backward nation is described as having untapped resources and as possessing great natural beauty, but a technologically advanced nation is described as a military threat and as a political democracy, then the two represent cognitions from diverse domains. Following Zajonc (1960), the complexity of an object is viewed as the number of (different) ideas a person has about it. Viewed geometrically, complexity represents the number of different dimensions onto which an object is projected.

Angles among lines in the geometric model are determined by the experienced or imagined characteristics of objects in a domain. Together these lines constitute the multidimensional space in which all objects are accommodated and to which any new object (stimulus) may be assigned. The dimensionality of this space is, geometrically, the number of dimensions worth of space required to accommodate all objects. Psychologically, it represents the independent considerations brought to bear by a person appraising a set of objects or cognitions.

The model (and its measurement) differs from others in making a distinction between attributes which may be obliquely related and dimensions encompassing the attributes which must be orthogonal. Some theorists would view such a distinction as artificial, obtained in the interest of mathematical neatness, but unfortunately, not representative of human structural cognition (e.g., Streufert and Streufert, 1978). Scott's approach differs from those efforts, however, by not considering systematic variation of the objects in potential perceptual space. In other words, such problems as "stressors" originating through specific conditions of environmental complexity are not considered.

RESEARCH

A Summary of Complexity Research Efforts through Early 1977

A detailed review of research on the effects of complexity has been conducted by Streufert and Streufert (1978). The interested reader who wishes to obtain detailed information is refered to that source. This chapter will merely summarize the conclusions reached by that review.

If consistency, as has been suggested, is indeed the "hobgoblin of little (undifferentiated) minds," then one might expect a negative relationship between consistency seeking and complexity. It appears that consistency is negatively related to cognitive complexity, no matter how complexity is measured. Research data also suggest that cognitively more complex subjects form more complete and more balanced impressions of others when presented with some form of an impression formation task. Differences among more complex and less complex subjects can, however, be decreased or eliminated by a number of environmental conditions or instructions, e.g., stress, information overload, or a "set to evaluate."

Earlier theoretical propositions suggested that complex individuals should be more open to information (of all kinds) than their less complex (but in all other aspects equal) counterparts. While some researchers appear to have obtained data in support of this assumption, more careful experimental design has shown that information orientation interacts with stimulus/stressor conditions. Apparently less complex persons are more bound by the information obtained from the environment: they search more (than complex persons) when they experience information deprivation, but they search less when they are already overloaded. More complex persons tend to rely, in part, on their own integrative efforts and consequently are not as externally information bound. In addition, complex subjects seek more novel information and search across a greater number of information categories.

Research on attitudes and potential for social influence has been carried out both in restricted (sensory deprivation) and in normal environments. Generally it has been found that attitudes of less complex persons are less moderated by differing considerations and are somewhat resistant to change. If, however, the information provided is made salient (e.g., in sensory deprivation), attitude change is more easily obtained for less complex persons. Interpersonal attraction appears to be greatest among persons of higher levels of cognitive complexity. However, similar complexity (no matter at which level) can also be useful in increasing attraction (at lower levels, similar content, e.g., attitudes, appears to be a precondition, however).

Several researchers have investigated whether complex persons are more flexible and/or more creative. While the data on this issue cannot be considered conclusive, they at least suggest that a tendency toward greater flexibility exists, allowing the kind of flexible behavior that can and often does result in acquiring additional cognitive complexity.

Efforts to investigate the tendency toward extreme judgments have been reported by a number of early researchers. Two diametrically opposed theoretical arguments have been advanced. Harvey and associates (e.g., White and Harvey, 1965) believe that the greater number of judgmental dimensions involved should produce an "averaging response" in the more complex persons, allowing less complex respondents to respond with more extreme scores when the selected scales are salient. On the other hand, Nidorf and Argabrite (1970) believe that the available multidimensionality should make complex persons more confident, allowing them to respond in more extreme fashion. Unfortunately, the data do not allow us to select one or the other of these views as accurate: inconsistent results have been obtained by various researchers.

Research on problem solving and decision making has, however, produced quite consistent results. It appears that more complex subjects search for more different kinds of information when they are faced with a decision making problem and are less certain when they have made a decision (for which no immediate correct/incorrect outcome information is available). More complex subjects also reach higher levels of strategic action and of planning than their less complex counterparts, yet these discrepancies are restricted to conditions of intermediate environmental load (and other environmental complexity) levels. Similar data are obtained for information utilization. It appears that higher levels of strategic or planning performance is a linear function of the number of complex persons in a decision making group.

Training to differentiate and/or integrate a single domain of relatively simple tasks appears to meet with some success. Single sets of instructions on how to perform in more complex fashion did, however, produce even more unidimensional responding in less complex subjects.

Several theorists have suggested that cognitive complexity should show some relationship to leadership. Comparison of leadership styles indicates that more vs. less complex leaders apparently emphasize different kinds of the leadership styles listed by Stogdill (1962). Considerable discussion about a potential tie between Fiedler's (1958) Least-Preferred Coworker (LPC) Scale and measures of complexity has also appeared in the literature. Both the score a person obtains on the LPC and the variability of responses on the LPC have been advanced as supposed indicators of cognitive complexity. The argument that a person who sees some values (based on multiple dimensionality) in even the least preferred coworker might also score higher on measures of differentiation, appears, at first thought, to have some credibility. Data relating LPC to various measures of complexity are, however, quite inconsistent. Since some researchers obtained positive; others, negative; and yet others, no relationship, the possibility of interaction with third variables certainly exists.

Cognitive complexity has been shown to relate to the ability of clinicians to interact successfully with patients or clients. Again, a match in complexity was helpful and greater complexity of the clinician was an aid in "reaching" the patient. Some preliminary research has also suggested that elevated GSR measures were obtained from complex subjects and that schizophrenics generally scored low in cognitive complexity.

An interesting aspect of the various research efforts is the common predictive success for various complexity measures that, in and of themselves, fail to intercorrelate highly. It appears that complexity as a style may indeed be an overall phenomenon, that the various theories describe potentially quite diverse (summative) parts of that phenomenon and that the measures (see below) tend to focus on separate, yet coactive or interactive, components of complexity which together tend to produce an overall effect.

In a major review effort in the area of cognitive style, Goldstein and Blackman (1978) identified a number of constructs that reflect cognitive complexity or potentially related styles. For comparison purposes, they also consider authoritarianism, field dependence/independence, and dogmatism. A table, showing correlation values among these measurements which have been obtained by various researchers was presented by Goldstein and Blackman (p. 215 and following). Parts of that table are here reported in somewhat modified form. Goldstein and Blackman did not distinguish between measurement based on conceptual systems theory (e.g., Harvey et al., 1961) and interactive (integrative complexity theory) (Shroder et al., 1967). Data obtained from those different points of view and associated (differentiative) measurement efforts are now separated. In addition, segments of the table are partially relabeled to reflect the terminology used in this paper. Some data that had been omitted by Goldstein and Blackman has been added.

TABLE 1. INTERRELATIONSHIPS AMONG COMPONENTS OF COMPLEXITY AND VARIOUS OTHER CONSTRUCTS
(adapted from Goldstein and Blackman, 1978)

Study	Instruments	Correlation	Sample
1. Differentiative Complexity X Conceptual Systems Complexity			
Harvey (1966)	Rep Test TIB Test	As expected	Summary of other data
Hunt (1962b)	Adaption of Rep Test SIE	.37	136 6th-12th grade boys
Epting & Wilkins (1974)	Bieri Rep Test Conceptual Systems Test	.31	90 undergraduates
	Bieri Rep Test PCT	-.31	90 undergraduates
Smith & Leach (1972)		NS	27 unspecified
	Bieri Rep Test TIB Test	Significant	27 unspecified
	Hierarchical measure of cognitive complexity TIB Test	(Mann-Whitney U = .50)	

TABLE 1. INTERRELATIONSHIPS AMONG COMPONENTS OF COMPLEXITY... (continued)

Study	Instruments	Correlation	Sample
2. Differentiative Complexity X Integrative Complexity			
Streufert (1970)	Rep Test	Low and sometimes negative	Summary of other data
	SCT		
Vannoy (1965)	Modified Bieri Rep Test	NS	113 male undergraduates
Streufert (1972, unpublished)	SCT, Scored for integration Rep	.12	340 undergraduates
	SCT, Scored for differentiative Rep	+.69	340 undergraduates
3. Differentiative Complexity X Field Dependence			
Elliott (1961)	Modified Bieri Rep Test	NS	128 male undergraduates
	RFT		
	Modified Bieri Rep Test	NS	128 male undergraduates
	EFT		

TABLE 1. INTERRELATIONSHIPS AMONG COMPONENTS OF COMPLEXITY... (continued)

Study	Instruments	Correlation	Sample
4. Conceptual Systems Complexity X Field Dependence			
Stewin (1976)	ITI, TIB Test Group EFT	NS	100 11th-graders
Wolfe, Egleston & Powers (1972)	PCT EFT	NS	32 undergraduates
5. Integrative Complexity X Field Dependence			
Stewin (1976)	PCT Group EFT	NS	100 11th-graders
6. Dogmatism X Differentiative Complexity			
Bieri (1965)	Dogmatism Scale	.27	Females, unspecified
	Modified Rep Test	NS	Males, unspecified
Pyron (1966)	Dogmatism Scale Modified Rep Test	NS	80 undergraduates
Starbird & Biller (1976)	Dogmatism Scale Bieri Rep Test	NS (F Test)	180 undergraduates
7. Dogmatism X Conceptual Systems Complexity			
Harvey (1966)	Dogmatism Scale TIB Test	As expected	Summary of other data
Rule & Hewitt (1970)	Dogmatism Scale	.23	91 male undergraduates
	ITI	NS	113 female undergraduates

TABLE 1. INTERRELATIONSHIPS AMONG COMPONENTS OF COMPLEXITY... (continued)

Study	Instruments	Correlation	Sample
8. Dogmatism X Integrative Complexity			
Schroder, Driver & Streufert (1967)	Dogmatism Scale SCT or IFT	Low	Summary of other data
Schroder & Streufert (1962)	Dogmatism Scale SCT	NS	147 male high-school students
Streufert & Driver (1967)	Dogmatism Scale IFT	NS	124 male under-graduates
9. Authoritarianism X Differentiative Complexity			
Bieri (1965)	F Scale	.45	Females, unspeci-fied
	Modified Rep Test	NS	Males, unspecified
Pyron (1966)	28-item F Scale Modified Rep Test	NS	80 undergraduates
Vannoy (1965)	10 original and 10 reversed F-scale items Modified Bieri Rep Test	.20	113 male under-graduates

TABLE 1. INTERRELATIONSHIPS AMONG COMPONENTS OF COMPLEXITY... (continued)

Study	Instruments	Correlation	Sample
10. Authoritarianism X Conceptual Systems Complexity			
Harvey (1966)	F Scale TIB Test	As expected	Summary of other data
Rule & Hewitt (1970)	28-item F Scale	.39	91 male undergraduates
	ITI	.29	113 female undergraduates
11. Authoritarianism X Integrative Complexity			
Schroder, Driver & Streufert (1967)	F Scale SCT or IFT	.25-.55	Summary of other data
Schroder & Streufert (1962)	30-item F Scale SCT	.34	147 male high-school students
Streufert & Driver (1967)	F Scale IFT	.18	124 male undergraduates
Vannoy (1965)	10 original and 10 reversed F-Scale items SCT	NS	113 male undergraduates

Recent Research

About half of the 600 or so manuscripts which have become available on cognitive complexity since the latter part of 1977 are dissertations. They have not been included in this review. Consideration of complexity research published in the last four years is limited to journal publications and chapters where either the quality of design, data collection, and analysis was sufficient to merit consideration, or where the weight of several papers with similar results (despite limited quality) would suggest that a reliable conclusion may have been reached. Discussion of the research will be achieved through use of a number of subheadings.

1. Communication.

Hale (1980) has shown that complex persons are more effective at a communication dependent task (describing a complex tinker-toy design) than are unidimensional individuals. Complexity was also positively related to interaction frequency (Zalot and Adams, 1977). Part of the greater success of more complex persons may be due to their greater ability to be intimate with others (a finding that holds only for integrators, but not for differentiators (Neimeyer and Banikiotes, 1980)). Finally, more complex persons, as compared to their less complex counterparts, are more resistant to persuasive attacks if inoculated (Cronen and Lafleur, 1977).

2. Attitudes, Attributions, and Attraction.

Bhutani (1977) reported that attitude change is more easily achieved in complex individuals. This result is probably due to greater consideration of additional (including novel and unexpected) information, resulting generally in greater evaluative moderation (c.f., Linville and Jones, 1980). Such moderation, incidentally, appears to apply more in familiar than in unfamiliar contexts.

Similar data are also reported by Okeefe and Brady (1980) who found that non-complex subjects were much more likely to polarize after thought about a subject matter.

Findings of this nature would, of course, make the concept of cognitive complexity more interesting to applied researchers who use attitudes and intentions for specific ends, e.g., researchers concerned with marketing. Research has generally confirmed that complexity is directly related to attitudes or attributions which are product relevant. For example, Durand (1980) obtained results indicating that complexity is related to affect and dispersion of affect ratings for brands of toothpaste and automobiles. Specifically, consumers with less differentiative ability tended to be more alienated (Durand and Lambert, 1979; c.f., Durand, 1979). In part as a result, less complex subjects formed more extreme (but potentially alienated) attitudes and tended to be more confident about those attitudes (Mizerski, 1978). These data are reminiscent of the earlier work of Sieber and Lanzetta (1964) with decision making and complexity.

Moderation of attitude may impinge on the attractiveness of persons. In line with previous findings (discussed earlier), greater complexity may make a person more attractive to both more and less complex people. While previous research (above) had shown that it is of advantage to counselors to be complex (multidimensional) if they are to be attractive to clients, the more recent data (reported by Davis, Cook, Jennings, and Heck, 1977) reverse the direction of source and target of attractiveness: more complex clients appear to be more attractive to both more and less complex counselors. The generality of the attractiveness findings in earlier research and the presently discussed efforts appear to suggest that the relationship between complexity and attractiveness to others appears to be a quite reliable phenomenon that can likely be generalized to other situations, e.g., supervisor-employee settings.

3. Leadership.

The interest in the relationship between leadership and cognitive complexity has continued in recent years, testing whether the assumption of Mitchell (1970) that there is a clear relationship between these variables is defensible. Generally, the data either do not support (or provide only very limited support) for the proposed relationship (e.g., Arnette, 1978; Schneier, 1978; Vecchio, 1979; Weiss and Adler, 1981).

4. Information Orientation.

Recent data continue to support the earlier finding that complex persons are more widely information oriented, conditions permitting. Research indicates that some other variables, such as Machiavellianism and social intelligence can be partialed out without loss to the complexity effect on information orientation (e.g., Hussy, 1979). Complex persons (here managers) were also found to be more effective in terms of information utilization (Hendrick, 1979).

5. Perception.

How information received by a person is perceived has been of continued interest to complexity researchers. Part of that interest probably stems from the "social perception" orientation of most of the earlier complexity theories. The data obtained by a host of researchers support the notion that complex persons are "better" at perception, i.e., will take more information into account, will form more rounded impressions, and so forth. Many of the findings are explained by researchers in terms of a "good" vs. "bad" way to be, i.e., it is good to be complex, bad not to be complex. This notion, however, has no basis, in fact. Not all situations and all tasks require or even warrant complexity, particularly if it is a pervasive style that cannot be "turned off" when inappropriate.

Research supporting the greater breadth of information orientation for complex persons has been obtained from a divergent range of settings and tasks. For example, complex persons seem to spread their cognitive categories more evenly across observed others, regardless of the role in which those others are perceived (Okeefe and Delia, 1978 1978). Perceiving others in such fashion reflects potential differentiation and at least some integration, leading to less rejection of inconsistency in received information (Wojciszke, 1979) and more openness to inconsistent verbal messages (Domangue, 1978). As a result, polarization of attitudes after perception and thought is lessened for the more complex subjects (Okeefe and Brady, 1980). Yet, it is not only the external cues which appear to be perceived differently by more complex subjects; the cues are also integrated into their perceptual framework in a more extensive fashion. As a result, the more complex persons appear to base their evaluation of others on (perceived) internal motivational characteristics rather than on just external behavioral characteristics. Consequently, the quality and quantity of hypotheses about the behavior of others are likely to increase and the number of questions raised about the underlying causes of another's behavior are likely greater for complex persons (Holloway and Wolleat, 1980). Greater quality and diversity of hypotheses and questions would decrease the need for evaluation as a sole determinant of perception, again resulting in greater complexity (Wojciszke, 1979). Not surprisingly, specific social perceptual complexity appears to be greater for females than for males (Zalot and Adams, 1977).

A number of researchers have focused on the characteristics of the stimulus, or upon its relationship to the perceiver, as related to the utilization of a person's potential complexity. It appears that close emotional involvement with another is likely to reduce the complexity of perception under some (but not all) conditions. Generally, individuals whom one knows less, or with whom one is less

involved, may be perceived in a more complex fashion. For example, Wojciszke (1979) found that little known, ambivalently, or even negatively valued persons are perceived in a more complex fashion than well known, positively valued persons. However, once negative valuation turns into dislike, complexity of perception appears to be reduced. Cioata (1977) reported that persons are significantly more complex in evaluating liked than disliked persons and are more complex in evaluating themselves than others. A somewhat inconsistent result was reported by Horike (1978) suggesting that a V-shaped relationship exists between complexity of perception and degree of acquaintance. Since this author manipulated acquaintance in the laboratory, it is not clear whether the data are comparable to those of other researchers. Finally, absence of information and absence of interest with regard to others (here, political candidates) tends to reduce the complexity of perception (Mihevc, 1978).

6. Development and Personality.

A number of authors continue to research the relationship of cognitive complexity to development (in Piagetian and other terms). Generally, the findings suggest that cognitive complexity can increase through childhood years and may be related to stages of development proposed by Piaget and others (e.g., Beagles and Greenfield, 1979; Chandler, Siegel, and Boyes, 1980; and Delia and Clark, 1977). Developmental differences appear to lead to specific behavioral characteristics which can, in part, be assigned to personality content. For example, Bruch, Heisler, and Conroy (1981) have shown that more complex persons display greater content knowledge, greater delivery skills, and more assertiveness when placed into difficult situations. Differences were not obtained in more simple situations. Other findings suggest that persons who are cognitively complex score higher on ego identity (see the section on clinically oriented research below).

It has been argued repeatedly that complex persons should be more creative (but not necessarily on simple creativity tests) when creativity is measured in applied settings. Research by Quinn (1980) has supported these assumptions: a significant difference in cognitive complexity was obtained between creative writers and matched controls. No differences between writers with different degrees of creativity was obtained (this result is likely due to the author's selection of a complexity test which measures only differentiation).

7. Clinical Applications.

Personality measurement as it relates to clinical applications has generated a number of relationships to cognitive complexity. Complex persons who scored higher in ego development (Vetter, 1980), in both the U.S. and in Germany, tended to feel less alienated (Durand and Lambert, 1979), and proved to be more emotionally stable, but potentially more anxious (Cioata, 1977). The finding on anxiety is, however, contradicted by other research (Raphael et al., 1979). Part of the reason for the differential findings may be the adaptation of the respective person to his or her particular problem or situation. For example, experiencing an emotional handicap may increase cognitive complexity (Vace and Burt, 1980).

8. Performance.

The previously discussed research topics have been focused on the stimulus, on perception, and on personality outcome. We now turn to behavior, focusing first on general performance, and continuing (in the next section) with decision making performance as a special case.

One would not expect that all kinds of performance in all environments would necessarily be affected by cognitive complexity.

Indeed, several studies show no relationship. For example, Wolfe and Chacko (1980) found that complexity did affect the perception of a business game environment, but did not produce any changes in performance outcome. On the other hand, complexity does appear to have considerable influence on performance measures in a variety of other task settings. Jones and Butler (1980) report significant correlations between complexity and global indices of job performance among Navy personnel. Hendrick (1979) found that less complex persons took twice as long as complex persons to complete a problem solving task. More complex groups interacted at a faster pace and demonstrated better cue utilization. In yet other research, complexity predicted performance in a fault diagnostics task (Rouse and Rouse, 1979) and related to risk taking in traffic situations (VanEye and Hussy, 1979). The conclusions reached by Hussy and Scheller (1977) sum up the results of a number of studies concerned with performance. These authors concluded on the basis of their own research that variables involved in cognitive complexity are probably the most predictive and discriminative for problem solving tasks.

Following the earlier demonstration of environmental effects on performance and their interaction with cognitive complexity, a number of researchers have more recently explored the effects of "overload" and related variables in tasks which differ from those employed by Streufert and associates. The data reliably suggest that excessive load is detrimental across a number of diverse tasks. For example, Rotton, Olszewski, Charleton, and Soler (1978) report that overload (via loud noise, loud speech) reduces the ability to tolerate frustration, and the ability to differentiate among roles occupied by persons. White (1977) concludes that less complex persons become overloaded and show the effects of overload sooner than more complex persons (this data appears to be in contradiction to the majority of findings on complexity, load, and performance which has suggested no significant differences between more and less complex

persons in optimal environmental input levels. In a review of 75 publications relating environmental complexity (including load) to performance, Shalit (1977) concluded that effectiveness of coping appears inversely related to the complexity of the situation. It should be noted, however, that the majority of the reviewed research efforts have concentrated on overload only, and did not consider the effects of less than optimal load (or other environments).

9. Decision Making.

In a series of studies by Suedfeld and associates (e.g., Suedfeld and Tetlock, 1977; Porter and Suedfeld, 1981), the conceptualizations of political and literary figures across several centuries were analyzed and related to decision making outcome and similar measures. The data indicate that a lowering of differentiative and integrative complexity (e.g., in the content of speeches made) precedes hostility (e.g., the decision to go to war), and that failure to increase complexity after the end of a crisis (here, revolution) results in failure (removal of the leadership which has successfully completed the revolutionary process). In addition, it appears that complexity decreases with illness and in the five years prior to death, but otherwise increases with age.

Following the arguments of Suedfeld and the earlier work of Driver (1962); Levi and Tetlock (1980) analyzed the period preceding the Japanese decision to go to war (World War II). They found relatively weak evidence for cognitive simplification as the decision to engage in warfare was made, but showed that the discussions held during decision making meetings at that time were representative of lower levels of complexity than the meetings where these decisions were presented to the emperor for approval.

The previous work of Streufert, confirming a family of inverted U-shaped curves relating environmental complexity to strategic (and planning) performance (with different levels of the family of curves representing diverse degrees of cognitive complexity), continued to be replicated during this period. Interesting are the additional data showing a weak relationship of cognitive complexity to Type A coronary prone behavior, but showing, in addition, that greater cognitive complexity produces greater arousal under challenge (measurement of heart rate and systolic/diastolic blood pressure). This arousal discrepancy between more and less complex persons could not be explained via the low order correlation of complexity with Type A (Streufert, Streufert, Dembroski, and MacDougal, 1979). Other research did indicate, however, that time urgency (a component of Type A behavior) is able to depress differentiation and integration in decision making, even under optimal load conditions (Streufert, Streufert, and Gorson, 1981). Research by Harren, Kass, Tinsley, and Moreland (1979) has related complexity to career choice; work by White (1977) indicates that a task in which a person must analyze the social structure of a group on the basis of partial information is performed better by complex subjects when the number of relationships that must be estimated is relatively large.

a. <u>Single Strategy Decision-Oriented Approaches</u>.

Decision situations often may present themselves as being either well structured or ill structured. Well-structured decision problems usually require only routine transformations which may take the form of algorithms or heuristics. An algorithm may be thought of as an operation that guarantees a solution in a known situation with a finite number of steps. Heuristics may be thought of as more generalized, outlined rules of thumb which have proven historically to be useful, but

which may not guarantee success (MacCrimmon and Taylor, 1976). Heuristics may be internal to the decision maker (such as "ethics" or "common sense") or they may be imposed by the environment (such as company policy or conventional wisdom). Algorithms are typically internalized from the environment via education or experience. Toda (1976) suggests that these repeatedly used approaches often become automatic and can be disadvantageous or detrimental if they lose their relevance in a rapidly changing world. Svenson (1979), on the other hand, sees them as simplifying strategies which a decision maker may use in a complex, multi-attribute alternative situation to arrive at a decision more easily.

Ill-structured problems are more common and demand that a decision maker exert more effort to find effective strategies for solving them. Ill-structured decision situations are those which are characterized by uncertainty, complexity and/or conflict (MacCrimmon and Taylor, 1976). The effort to explain how these conditions are contended with has produced works suggesting a variety of techniques which might be used to reduce or cope with them. Jones, Schipper, and Holzworth (1978) suggested that four intrinsically available decision strategies exist regarding probablistic "cues." They hypothesized that a decision would be based on: (1) the sum of cue values which is largest among alternatives, (2) the largest cue average, (3) the largest single cue, or (4) the alternative with the most cues. Similarly, Olshavsky (1979) presented five

strategic models. In the Additive model, the overall worth of each alternative is first assessed and then a final ordinal comparison is made on the basis of this index. The Additive Difference model involves pair-wise comparisons of the alternatives in distance terms along separate dimensions, followed by a summation across differences. Attribute Dominance concerns one alternative dominating another simply in number of attributes. The Conjunctive model is applied when a multiattribute alternative surpasses a standard or cutoff level; and the Lexicographic model requires that attributes are first ordered according to importance, than all alternatives are evaluated on the first attribute, with those not exceeding the cutoff level excluded. If more than one alternative remains, the second most important attribute is selected and the alternatives are evaluated on that cutoff limit. The process contines until only one alternative remains.

Svenson (1979) identified seven strategies or decision rules. Those represented by Jones, et al., and by Olshavsky were called by Svenson "rules without commensurability," meaning that attractiveness of attributes may not be compared or counterbalanced in a situation. Svenson expanded the list by adding rules which do allow commensurability. Her Ordinal Attractiveness model provides for maximizing the number of attributes with greater attractiveness: elimination by least attractive aspect, and choice by more attractive aspect. She also identified an Ordinal Attractiveness Difference model.

At a higher level of representation, Svenson introduced the concept of "utility." Her Interval Attractiveness (utility) and Commensurability rule allows for both addition of utilities where decision is based on a summation of all utilities for each alternative, and for addition of utility differences when a decision is based on differences between the utilities of different alternatives on the same attribute. Finally, Svenson suggested a Ratio Attractiveness and Commensurability rule which relates to subjectively weighted utilities models. Such models imply that the utility of each aspect should be weighted by the subjective probability of its occurrence when summing the utilities for an alternative.

Articles dwelling on singular strategies seem to be subsumed within the Svenson perception. For example, Larson's (1980) work on Expected Utility and Subjective Weighted Utility would fall under Svenson's Interval and Ratio Attractiveness categories. Park's (1978) Sequential Conflict Resolution model, which was based on earlier Elimination by Aspects models, and his Satisficing Plus model can also be placed in the higher level representations.

Svenson has suggested that noncommensurate rules represented simpler levels of cognitive operation while the commensurate rules represented more complex levels. She also noted that to implement the higher order, complex strategies, more information was needed. She recommended

verbal protocol (subject verbalizing the thought process as it proceeds) and information search tracing, such as eye movement or questions asked, as processes to identify the information gathering activities used in reaching a decision. She felt that they would provide enough information to infer the process used. However, she stopped short of inferring detailed predictions about the cognitive complexity of a decision maker relative to the complexity of the decision process used. Her methods demonstrated fluctuation between simpler and complex strategies rather than a preferred level dependent on an individual decision maker. She suggested that this may reflect the effort to simplify through heuristics on one point when a decision maker feels overwhelmed, and alternately, that the decision maker who feels no overload may display stimulation seeking by more detailed evaluation, using more complex rules.

Wright (1979) traced strategies to determine the level of "effort" associated by a decision maker using various strategies considered to differ in complexity. He found no significant difference reported by subjects using rules with different levels of complexity. This would seem to counter the temptation to assume that the noncommensurate strategies, assumed to be simpler, are primarily used by subjects with limited cognitive resources, or that commensurate strategies are available only to those with wider ranging cognitive resources.

Svenson concluded that it is difficult to generalize over different types of decision problems since different subjects perceive the same objective decision problem in different ways, and they react in relation to their own perceptions. Identical rules may result in different final decisions for different subjects. Svenson's and Huber's (1980) work ultimately led them to conclude that the studies of individual decision rules are not productive because decision making is a multi-stage process with differing levels of complexity at different stages.

Einhorn and Hogarth (1981) suggested that a multi-method approach might be more fruitful; and Milburn (1976), and Park (1978) also agreed that rules do not adequately account for decision flexibility. Park describes decision making rules as overlapping and crudely ordered phases with interrelated decisions at each step, indicating a complex process which demands a more integrated model. Park adds that decision rules taken alone and studied for prediction or description assume that decisions are made without regard for the cognitive capacity ("bounded rationality") of the decision maker, and, thus, are of questionable value by themselves.

b. Multi-stage Processing.

A reasonable next step toward a more complex representation of decision making is shown in works which attempt to model how the various decision rules identified, but found wanting, in the previous section of this report are combined into strategies or

pre-planned sequences of goals to arrive at a decision. Efforts at this level try to identify which rules are applied and what factors relate to changes among the rules.

Perrault and Ross (1977) used verbal protocol techniques to determine whether the simple linear (noncommensurate) rules were sufficient in a multiattribute condition. They found that linear concepts showed little evidence that they are really descriptive enough to account for decisions in multiattribute situations. They found that the more complex Lexiocographic models were more appropriate when evaluation of alternatives is required. Olshavsky (1979) attempted to determine the effect of multiattribute and of multi-alternative dimensions on various decision strategies employed, and found that as number of decision alternatives increased from three to twelve, subjects typically switched from one-stage compensatory strategies to multi-stage processes involving screening and then evaluating remaining alternatives, with weighting processes as subroutines. He assumed that the strategy chosen was contingent upon the number of alternatives and attributes of the alternatives, and that the more complex strategies came into play when the numbers of each increased. However, he also found wide variations with respect to the numbers both of alternatives and of attributes that caused complexity levels to change.

Christensen-Szalanski (1978) viewed strategy selection as contingent upon the characteristics of the decision task, and also as contingent upon the characteristics of the decision maker. He acknowledged that each person has a repertoire of methods for dealing with problems and making decision, but also suggested that in western cultures most educated people believe that the more thoroughly and systematically one approaches a decision (problem) the greater are the chances of being correct. That is, more analytic, formal strategies are seen as having a higher probability of being correct. Christensen-Szalanski assumed that the level and style of a strategy implemented would be related to the decision maker's conception of greatest expected net gain in a financial decision making taks. He concluded that the benefit of "correctness" would lead to longer time to the solution, and that the longer time would reflect the confidence of the subject in the decision or solution selected. Further, the more "value" to be gained in a situation would make more complex strategies worth the effort to employ them. This, in turn, would increase the subject's confidence in a solution or decision.

Such results are compatible with Svenson (1979), Park (1978), and Olshavsky (1979); all of whom suggested that effort minimization, where more complicated mechanisms are only applied where necessary, appears to be a common outcome. Olshavsky also noted that information overload could lead to simpler strategy applications. Such

works, however, raise questions about when and why decision strategies are switched in complexity level by decision makers, as none of them are able to predict level change, but merely to acknowledge it. They may, however, lend credence to Park's (1978) model of Operationalized Satisficing Plus strategy which suggests that simplified representations of problem or decision situations are created by "chunking," or re-categorizing dimensions, and then alternately reducing and choosing from among remaining alternatives. Park suggests that his model showed significant prediction capability as compared with unsequenced decision rule models. The unsequenced rules, Parks feels, represent only pieces of the overall process, while his representation appears more comprehensive.

Going beyond simple efforts to identify conditions relevant to sequencing decision rules, Einhorn and Hogarth (1981) have recognized the possibility of the sequential use of cognitive processes within decision makers. This suggests that multi-method efforts will be needed to reveal and model individual decision processes in full. Attention, memory, cognitive representation, conflict resolution, learning, feedback effects, and even creativity and concept formation: all are seen as intertwined in the decision process and must be considered and integrated into studies for a complete picture of decision making as a process to emerge.

c. Computer-Based Decision Support.

Recent advances in the area of computer-based decision support deserve mention. One of these, termed Decision Support Systems (DSS), has been reviewed by Watkins (1982). According to Watkins, information supplied by a DSS must be selective in that not all possible information sets may be feasibly or economically represented in a given data base. Watkins has suggested that discovery of perceptual complexity (dimensionality) of information items, and the subsequent categorization of decision makers having the same perceptions of those information items, is a first step in the ultimate design of an effective DDS. Through the use of multidimensional scaling in a field setting, Watkins has shown the feasibility of creating relatively homogeneous groups of decision makers according to the content and number of dimensions associated with various information items. Further results of the research have suggested that information can be tailored to classes of users, which has cost-benefit implications as well as the potential to improve the quality of the resultant decisions.

If decision makers' perceptions of information are able to influence the decision process, information system designers need an understanding of the way in which perceptions affect that process. This understanding seems particularly critical for top-level decisions which are complex, unstructured, and have long-range implications. Perhaps perceptual commonalities can be found among decision makers to enable the formation

of relatively homogeneous groupings of decision makers. Such a finding would allow information reports to be tailored to groups of decision makers, as opposed to the more costly, and perhaps infeasible, tailoring of reports to individuals.

It has been argued that DSSs should be tailored to decision activities rather than decision makers due to potentially costly design changes caused by frequent turnover of decision makers. While this argument may be valid at the operational or management control level, it is less important at top management levels, which are generally characterized by greater stability and less turnover than are the lower levels of the organizational hierarchy.

A second effort, an overall approach to the issue of computer compatibility with decision style, termed SIMTOS, was described by Strub and Levit (1974). According to this approach, the concept of decision style, while rooted in cognitive and personality theory, has found application in computer system design as a basis for decision aiding. As used in an information system context, decision style may be defined as the characteristic and self-consistent way an individual uses information in the decision making process. A model of decision style was developed to classify eight styles according to three dimensions.

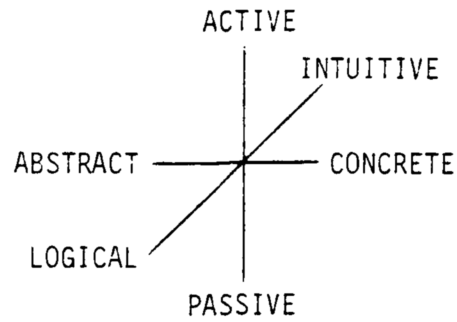


Figure 1. Dimensions of Decision Style

The model hypothesizes that individuals differ in the way they acquire and organize information: some use concrete information (e.g., maps, personnel figures) more than abstract information (e.g., policy). Individuals also differ in the way they assimilate and process information: some follow heuristic patterns (i.e., they are more intuitive), others strictly follow established decision rules or algorithms (i.e., they are logical). Finally, some take vigorous, aggressive and forthright action. They are active, while others are more conservative in their activities and are considered passive.

The methodology for assessment of decision style, developed by Strub and Levit, centers around a diagnostic inventory called the Decision Style Measurement Instrument (DSMI), an instrument designed for determining individual differences in information processing among decision makers, using a methodology pioneered by Briggs-Myer (1962) for the type Indicator.

Research by Pask (1971) and Morris (1967) illustrates that if there is a mismatch between decision style and mode of information presentation, large decrements in cognitive task performance can be expected. Decision makers need information consistent with their information processing characteristics, not information that is determined by computer system constraints (Henke, Alden, and Levit, 1972).

10. Training

If complexity can develop, and if, as described above, instructions in simple tasks may allow an otherwise less complex person to respond similarly to a more complex person, then complexity may by trainable. Theoretical points of view on training vary, yet, in all probability, none of the theorists reviewed would predict a rapid and overall training potential. Little research on training effects has been performed. The results of the few completed studies are equivocal. For example, Sauser and Pond (1981) were not able to obtain any change in complexity with their combination of training procedures. On the other hand, Cronen and Lafleur (1977) using an inocculation/persuasion paradigm were able to obtain some increase in overall complexity with massive attacks on truisms. Whether the results reported by these authors are, however, due to a real increase in complexity or may be explained by learning of procedures and/or arguments cannot be determined without further research. Generally speaking, the area of complexity training is probably the least researched area of cognitive and environmental complexity.

One study (Stabell, 1978) did investigate directly the relationship between training-oriented requirements and applications

of cognitive complexity. Stabell has correctly suggested that much work needs to be accomplished to define the task characteristics associated with cognitive decision making and how these characteristics interact with performance success in decision making tasks. Stabell found that the volume and breadth of information source use in the problem finding phase of the decision making process are positively related to the integrative complexity of information environment perception, and thus underlines the importance of detailed task analysis and task modeling in research on individual differences.

Summary

Clearly, much of the earlier, and a considerable amount of the later, research on cognitive complexity has focused on perception with only minor, if any, interest in the interactive effects of environment and a person's (group's) cognitive structure. Some of the later research based on interactive complexity theories (Schroder, Driver, and Streufert, 1967; Streufert and Streufert, 1978) has taken a more interactive, and consequently applicable approach. Generally, the reported research, based on the latter theories, is strongly supportive of the assumption that cognitive complexity has considerable impact on information processing and on the outcomes of that effort, both in the social and non-social, both in the perceptual and the performance realms. However, as discussed earlier, not all research has supported the contention that complexity is causal of or related to specific perceptions or behaviors. Such an all encompassing effect of complexity should not be expected. Differentiation and/or integration should occur only in environments where these structural characteristics can be appropriately applied and where they are useful to understand and/or solve the problems at hand.

MEASUREMENT

In dealing with the complexity literature, one finds that the utilized measurement techniques can effectively divided into two relatively distinct categories: (1) measures of cognitive information processing, yielding scores of differentiation and/or integration in the comprehension and organization of (typically social) stimuli; and (2) measures of differentiation and integration in performance, reflecting strategic action and long range planning. Measures developed during the early stages of the various complexity theories are typically of the first kind, designed to select more or less complex persons from some population. Measures of performance, decision making, and so forth, as a rule, were developed later when questions of the relationship between the complexity of input processing and output were raised. This discussion will deal with the two kinds of measures separately.

Measures of Cognitive Information Processing

Measures of cognitive information processing, most often focusing on perceptual modes of cognitive processing, have been primarily designed as selection instruments to distinguish between persons differing in complexity. While some of the measures focused on differentiation, others have attempted to capture integrative style, and yet others appear to concentrate on discrimination (i.e., upon single dimensions). Generally, research has demonstrated that the intercorrelation among certain groups of measures may be high, yet correlations among the various groupings of measures may be quite low (e.g., Vannoy, 1965). The reason for such low intercorrelations may be found in the different components of complexity that tend to be assessed by the divergent groups of measures (one would, for example, not expect tests of differentiation and integration to correlate very highly). While it is true that differentiation is a

necessary, but not sufficient, precondition for the capacity to integrate, the integrative process achieving (temporary or even exploratory) single outcomes of the structural cognitive effort would register as low complexity on any test of (purely) differentiation, yet would produce high complexity scores on (purely) measures of integration. Streufert, and Streufert (1978) have observed that "persons selected on the various complexity measures (which often appear uncorrelated) tend to behave strikingly similar to others of the same complexity level across a number of tasks. Common behavior for more complex subjects and common behavior for more simple subjects tends to be the rule, diverse behaviors tend to be the exception. One might then propose that different tests of complexity, even though appearing on different factors in a number of factor analyses may in effect measure sub-components of a common multidimensional or multicomponent phenomenon" (p. 50). The present discussion will first present a short review of those measures, and will then discuss development and research efforts on measures of cognitive information processing that have been published in the last few years.

1. Measurement through Early 1977

The oldest, and probably most frequently utilized (modified), measure of complexity is Kelly's (1955) Role Concept Repertoire (Rep) test. In Bieri's (1966) modification, the test was specifically designed to measure differentiation, limited to the perceptual social domain. More than half of the research published on complexity over the years has used Bieri's version of the Rep as the only, or primary, selection instrument.

In general, the Rep Test is administered as follows: The subject is provided with a grid which contains a number of spaces (e.g., 10) for the person to be judged (columns), each labeled with a role title considered to be personally relevant to the individual (e.g., yourself,

father, boss, friend), and including both liked and disliked persons. A corresponding number of rows is provided for constructs. In some research using the Rep Test, these constructs are generated by the subject (as in Kelly's original test), while in other studies, the constructs (bipolar dimensions of similarity-contrast) are provided by the experimenter. It has been demonstrated by some researchers (Jaspars, 1964; Tripodi and Bieri, 1963) that the indices of complexity derived from own and provided constructs are comparable. However, others (e.g., Kuusinen and Nystedt, 1972) have reported results indicating that considerable differences between the effects of the two kinds of constructs may be obtained. Results appear to depend upon such factors as the type of provided constructs which are compared with individual constructs. Metcalfe (1974), on the other hand, found no differences between own and provided constructs for complexity (i.e., hierarchical structure) and for differentiation, but concluded that the use of own constructs is preferable, because his obtained correlations between results based on own and provided constructs were statistically significant, but not high. It appears, then; it may safely be assumed, in most cases, that the results obtained with the use of own vs. provided constructs are fairly comparable, although not necessarily identical.

In the subject-generated construct procedure, the subject identifies each of the roles in the columns with a real person. Then he is asked by the experimenter to consider three of these persons (which three are specifically designated) at a time. The subject generates the constructs by indicating, for each triad he considers, a way in which two of the persons are similar and the third is different. Different triads are considered in this fashion until all construct rows are filled. Each time the subject produces a construct, he places a check in the cells of the matrix under the two similar persons and leaves blank the cell of the differing person. After all rows have been labeled with constructs, the subject

reconsiders all dimensions and places additional check marks in the cells of those persons (in addition to the two original ones) who are also similar on that construct. This procedure yields a matrix of check patterns which respresents how S perceives and differentiates a group of persons relative to his personal constructs (Bieri, 1955).

Scoring is accomplished by comparing each construct row with each other construct row, for a particular person. All possible comparisons for all rows and all persons (e.g., 450 in a 10 x 10 matrix) are made, with a score of one (for example) given for every exact agreement of ratings on any one person (Bieri et al., 1966). The scores for all comparisons are then summed, yielding a total score. (In a 10 x 10 matrix, the highest possible score would be 450, indicating that the subject rated all persons the same way on all constructs.) The higher the total score for a subject, the lower his level of complexity, since the high score is indicative of the fact that he uses all his constructs in the same way, that they all have the same meaning to him. In other words, he is more unidimensional. A low-scoring subject is considered higher in complexity, using dimensions differently. Scoring procedures on the Rep Test differ among experimenters, but the interpretation of complexity as inversely related to total score is consistent.

Multidimensional Scaling (MDS) (Schroder, 1971) is perhaps the most mathematically sophisticated attempt to measure differentiating ability. In the MDS format, the subject typically is asked to make judgments of similarity or preference between pairs of complex objects. The resulting matrix is analyzed to determine the number of dimensions the subject probably used to generate his ratings. MDS has high predictive validity for differentiating ability, but not for planning performance, as it does not account for integration. MDS is relatively easy to administer and can be computer scored.

It has been hypothesized that the number of dimensions yielded in a MDS analysis relates to the individuals differentiating ability, and that the weightings of the dimensions yielded in the MDS analysis, or their obliqueness, relate to the individual's integrating ability. Although MDS studies have yielded some interesting results, it is unclear whether MDS will solve the measurement problem for integrative complexity theory. The parallel between dimensionality and differentiation is promising, but the relationship between the weightings of the dimensions and integration is unclear. Another realistic difficulty is the expense involved in the computer processing of each subject's similarity ratings.

Early data have demonstrated considerable predictive validity and sufficient reliability for the Rep test and some of its derivatives. One scoring modification (Smith and Leach, 1972) has been shown to produce positive correlations with Harvey's (see below) This I Believe (TIB) test, a measure derived from Harvey, Hunt, and Schroder's (1961) Systems Theory predictions.

The TIB Test (Harvey, 1964) has been used to test integrative complexity through the subject's relative degree of absolution-evaluativeness, positivity-negativity, etc. on certain beliefs. In the TIB Test, the subject is required to complete, in two or three sentences, phrases beginning with "This I believe about...." The dashes include referents to friendship, guilt, majority opinion, myself, compromise, and people. Harvey (1964) reports high predictive and construct validity and interrater reliability scores above .90. The major criticism levied against the TIB Test is that it confounds structure and content (Schroder, 1971). This criticism points out a violation of the major theoretical consideration underlying the cognitive-oriented simulations.

The "categorizing" measure of Zajonc (1960) has been widely used in earlier work on cognitive complexity. Respondents are first asked to read a letter which was supposedly written by an applicant for a job. They are asked to try to get a general idea of what kind of person the applicant is. They are then given a set of 52 blank cards. One characteristic which the respondents feel would describe the applicant is written on each card. As many cards as possible are to be used. Respondents are then told to sort the cards into as many broad groupings as they feel are appropriate. After completion of this effort, each group of cards is studied to see whether it can be broken down into subgroups. These groupings and subgroupings are used to determine the level of inclusion of "attributes," the basis for the computation of the complexity score. As with the work of Kelly, Bierie, and associates with the Rep test, this approach deals with differentiative complexity in a perceptual social domain.

Scott has developed a number of structural measures; however only his measurement of complexity is of interest here. Typically, Scott's measures are also most relevant to the perceptual realm; however, some are located in a different domain. For one of his major measurement techniques, for example, Scott utilizes nations as stimulus concepts instead of persons.

Scott bases his measures on information theory (Attneave, 1959). His formula for differentiation is a measure of the quantity of information obtained from a modified sorting task (Scott, 1959, 1962a, 1962b, 1962c, 1963b, 1966, 1969). Scott asks subjects to generate a list of "important" nations (or other persons), or provides subjects with such a list. Subjects are then asked to sort the nations into (potentially overlapping) groups on the basis of some attribute they possess in the mind of the subject. Absence or presence of the attribute is determined via inclusion of the nation in a specific group. If subjects obtain only one grouping, then two distinctions

are made. Nations are viewed as possessing, or not possessing, a particular characteristic, i.e., they are placed on a single dichotomous dimension (in Scott's terminology, attribute). If the subject sorts nations into two groups (with overlapping membership), then four distinctions may be made. For _k_ independent groups, the maximum number of distinctions would be $2^{\underline{k}}$, permitting description of the information contained in the sorting outcomes via logarithms to the base of 2 (Scott, 1962a). Scott makes a number of additional assumptions. He suggests that two groupings (even if named differently) which have identical members (and nonmembers) are empirically seen as representing the same attribute (dimension). He further proposes that groups with no overlapping members are likely to represent antithetical attributes (dimensions) or form different categories on the same dimension. In either case, no differentiation is implied.

The experimenter would be most certain that differentiation did actually occur when a subject orders groups in different ways along different dimensions (intransitivity). This would occur most clearly where there is 50 percent overlap among dichotomous attributes (dimensions) into which the stimuli (nations) are sorted. The measure of absolute complexity can be expressed by the formula (Scott, 1962a):

$$H = \Sigma p_i \log_2 \frac{1}{p_i} = \log_2 n - \frac{1}{n} \Sigma n_i \log_2 n_i$$

where

n = the number of objects (nations) obtained from the subject;

n_i = the number of objects that appear in a particular combination of groups; and

$p_i = n_i/n$ = the proportion of objects falling in the _i_th group combination.

Further, Scott obtains a measure for the relative complexity of a subject's sort by correcting for the number of nations generated (Scott, 1962a):

$$R = \frac{H}{\log_2 n}$$

Perhaps influenced by Scott's interest in measurement techniques for cognitive structures, several of his associates have also published measures which are of some interest. Wyer (1964) developed a measure of differentiation based on a person's attributed rating matrix (not unlike the Rep Test). Differentiation is defined as the number of distinct concepts in the cognitive domain, i.e., the number of distinctively rated stimuli. For example, if on a number of attributes (dimensions) persons are always rated in the same order, then only one dimension is present. To the degree to which any point on the dimensions is used more than once to place a person, and to the degree to which that placement is unique, a score for differentiation is given. If, on the other hand, two persons are placed together at that point who are also placed together on other points of other attributes, then differentiation is scored only once.

Wyer also presents two measures of integration. Integration is defined as the degree to which concepts and attributes contained in the cognitive domain are interrelated. Measure 1 calculates the number of subject responses which would infer other responses; e.g., if placing a person on Scale-point 3 on Scale A implies that he will then also place him at point 1 on B; 6, on C, etc., then the placement on Scale A can be inferred from two other placements: Score = 2. The effort necessary for calculating all these vales would be enormous, so Wyer limits himself to calculating only inferences for placement of persons on the three dimensions which the subject claimed were <u>most important</u>.

Wyer's second measure of integration again uses the three most important scales. Subjects are aksed to indicate the probability (0-1.0) that a person scoring high or low on each of these three dimensions would also score high or low on the other dimensions which the subject had generated (total of 10 dimensions, so there are 7 left for this purpose). For each pairing of one of the three "most important" with one of the seven other dimensions, the differences in the probabilities for the statements of high or low similarity were calculated. For example, if the probability that a person scoring high on dimension 1 (most important) is also high on dimension 7 is .9, and the probability that he is low is .1, then the difference is .9 - .1 = .8. If they are equally probably, then the probability is .5 - .5 = 0. The number of pairs which showed differences of greater than .5 was taken as a measure of interrelatedness of the structure (integration).

Unfortunately, Wyer's integration measures fail to correlate meaningfully with integration measures derived from interactive complexity theory (the latter have been widely validated). It is likely that the calculations utilized by Wyer are <u>not</u> appropriate for obtaining assessments of the flexible integrative capacity considered by Schroder et al. (1967) and by Streufert and associates (1970).

Crockett (1965) developed the Role Category Questionnaire, again a measure of differentiation complexity in the perceptual social domain. Crockett's measure of complexity (differentiation) is a count of the number of concepts that are used to describe different persons. The subject is asked to identify eight persons he knows. Half of them must be older than he; half, peers; half must be liked; half, disliked; half must be male; and half, female. The subject spends a few minutes comparing his persons mentally, and then

describes each of the eight persons (with a three minute time limit per person). The measure of complexity is represented by the number of different interpersonal constructs which the subject uses in the description. High complex subjects are above the median split of the distribution obtained from all subjects; those below the median are low in complexity.

Harvey, Hunt, and Schroder (1961) utilized a number of measures (often in multiple combination) to determine a person's "abstractness" based on their systems theory. The tests include Harvey's This I Believe (TIB) test, Schroder and Streufert's (1962) Sentence Completion Test (also, and possibly more appropriately, known as Paragraph Completion Test) (both requiring subjects to respond with several sentences to presented conflict dilemmas), along with some forced choice techniques in which subjects select between alternate solutions to conflict dilemmas. While the TIB and the Sentence (Paragraph) Completion Test <u>can</u> be scored for structural characteristics only (see below), Harvey et al. did confound content and structure in their scoring procedures as dictated by their theoretical assumptions. As used by these authors, these measures cannot be considered pure measures of cognitive complexity although they have been utilized for that purpose by researchers involved in interactive complexity theory (see below). In addition, scoring the measures as dictated by systems theory has produced limited reliability coefficients. The advantage of the efforts by Harvey et al. is the expansion of complexity domains into areas other than social perception. Subsequent researchers have used this advance to considerable advantage.

As reported by Goldstein and Blackman (1978), the Interpersonal Topical Inventory (ITI) is a forced-choice instrument developed as a measure of integrative complexity. It is a modification of an instrument developed in 1959 by Schroder and Hunt (cf. Schroder, 1971). On the ITI the subject is presented with six stems: "When I

am criticized...," "When I am in doubt...," "When a friend acts differently toward me...," "This I believe about people...," "Leaders...," and "When other people find fault with me...." For each stem, the subject is presented with six pairs of responses, and is asked to complete the sentence by indicating his choice of one of the responses from every pair.

Tuckman (1966) presented data from over 100 Naval recruits indicating significant differences in the SCT-measured level of abstractness for subjects that were classified on the basis of the ITI. He also presented data indicating a significant relationship (C = .54) between the SCT and ITI; and Suedfeld, Tomkins, and Tucker (1969) reported a significant correlation of .19 between the SCT and the ITI for a sample of 178 undergraduates. It should be noted that significant relationships between the ITI and measures such as the SCT (PCT) are significant only when the latter is scored according to the conceptual systems approach of Harvey et al., 1961. Correlations disappear when comparisons are made between ITI and the SCT (PCT) or the IFT scored according to interactive complexity theory approaches.

Researchers concerned with interactive complexity theory have primarily employed subjective measures to assess the complexity of their subjects. The most frequently used subjective test for complexity developed by researchers in this group is the Sentence Completion Test (Schroder and Streufert, 1962). Subjects write paragraph length (three to four sentences in a 2.5 to 4 minute period, depending on the population) responses to each of a number of incomplete sentences, such as "When I am criticized...." The sentence stems are selected to provide conflict settings to which subjects can respond unidimensionally or multidimensionally. Scoring of the tests is relatively easy, and one-day training will typically result in interrater reliabilities of above +.85. More extensively trained personnel tend to obtain reliabilities in the low 90s. Test-retest reliability

of the measure (if the tests are administerd properly) is near .85. The scores obtained on the two highest responses are usually taken as an index of the subject's complexity.

In an attempt to gain responses which are more relevant to the domain differences discussed by Driver and Streufert (1969), and Streufert and Driver (1967), Streufert and associates have modified the stems so that responses can be obtained for the following domains: (a) social complexity, (b) nonsocial complexity, (c) perceptual complexity, (d) executive complexity. Inter-correlations among these domains are typically .4 to .6. It should be noted that the test is scorable for both differentiation and integration <u>separately</u>. Scoring for differentiation alone produces low socres for integrators.

A second test that is used with some frequency is the Impression Formation Test (Streufert and Driver, 1967; Streufert and Schroder, 1963). As Crocket and associates have established, complex persons tend to integrate conflicting blocks of univalent information; less complex subjects, however, tend to respond with either primacy or recency, depending on the manipulation. This finding has been useful in establishing criteria for estimating interpersonal perceptual complexity on the basis of subjects' responses (cf. Streufert and Driver, 1967).

Attempts have been made to develop a number of objective measures of differentiation <u>and</u> integration. While some progress has been made (particularly recently), these tests are not yet quite ready for general use. The difficulty encountered in developing such measures is due to the individual differences in the <u>content</u> of domains. It is necessary to measure cognitive complexity <u>in terms of each individual's own content and structure</u>, permitting no overall test format. While the subjective measures employed by this research group (Schroder and associates; and Streufert and associates) have

yielded very high reliability and predictive validity across a number of domains, the objective tests so far have not fared as well. Consequently, they will not be considered here.

2. Recent Efforts Concerned with Cognitive Information Processing

Development of new measures of cognitive complexity has not been widely attempted during the last five years. Three sets of authors have reported new measures; however, all are either limited in usefulness or as yet insufficiently developed to be a significant contribution to the literature. For example, Metcalfe (1978) reports that his work on the Smith and Leach Hierarchical Complexity Index based on a 30-month test-retest correlation shows that measure to be somewhat reliable, but likely not exceptionally valid. Hussy (1977) reports an effort to develop seven separate measures of cognitive complexity (in German), but admits that the proof of reliability and validity for those measures is limited. Laucht and Krohne (1978) report similar problems with their test.

A number of researchers have considered the interrelationship among different measures of cognitive complexity. The concern with potentially lacking relationships was probably created by the results of several factor analyses reported in the mid-seventies suggesting low level relationships among complexity measures (for an explanation of those levels, see Streufert, and Streufert, 1978). Generally, the results obtained have been supportive of reasonable interrelationships among measures. For example, Okeefe, Delia, and Okeefe (1977) report that more complex subjects (selected on the Rep test) perform impression formation tasks by including information of more negative valence than do less complex subjects. The impression formation task employed is the basis of the Impression Formation Test utilized by interactive complexity theorists (Streufert and Driver, 1965). Raphale, Moss, and Rosser (1979) related the Sentence

Completion Test (Paragraph Completion Test), as used by Hunt, to the impression formation measure and found that more complex subjects perform better on higher level aspects of impression formation than do less complex subjects.

An interest in reexamining the reliability and validity of established (and previously validated) measures of complexity has continued as well. The results of these efforts demonstrate that the reliability and validity levels do hold up across time (and diverse sub-populations). For example, Schneier (1979) reports highly significant test-retest reliability and convergent as well as discriminant validity for the Rep Test across populations, sex, college major and level in organizational hierarchies. Lesser levels of reliability have, however, been reported when different populations (other than American, European, and related cultures) were tested. For example, Ohbuchi and Horike (1978) tested 40 male Japanese students. They reported reliability for measures of discrimination, but less consistency for a measure of dimensionality (differentiation). Indeed, differences among cultures and subcultures in complexity are clearly present and need to be examined further. Even within U.S. populations, such differences can be found. For example, Hogan and Mookherjee (1980) demonstrated considerably more variance in blacks than in whites, particularly black females.

Work concerned with specific measures of cognitive complexity has dealt with improving available tests (for example, Bell and Keen, 1980); has proposed a method for obtaining additional information from the Rep by scoring during the elicitation of the response; and has considered the relationship of complexity across domains (Poole, 1978).

Previous work, often based on factor analysis procedures, had indicated that cognitive complexity shows little relationship to

other personality or attitudinal measures. Indeed, such relationships should not exist: as long as a complexity measure is purely structural it should assess a style of dealing with information regardless of the content of that information. Recent efforts by a number of researchers have generally confirmed that relationships between cognitive complexity and other measures of cognitive styles are negligble or nonexistent and that relationships to measures of personality content and attitudinal content do not exist. For example, Kostlin-Gloger and Rottmair (1979) obtained no relationship between complexity (Rep) and reflectivity/impulsivity. Several sets of researchers have explored relationships of complexity with measures of conservativism and liberalism, but found no correlations which differed meaningfully from zero (e.g., Schneider, Kohler, and Wachter, 1979; Sidanius, 1978). Exploring the relationship of complexity to conservativism has been particularly interesting since Messick in an early Factor Analysis (in the 1950s) had shown that U.S. political conservatives utilized only one dimension of judgment in political perception, while liberals appeared to utilize two dimensions. It may well be that conservativism has changed since that time and that conservatives and liberals are now relatively equal in the number of dimensions utilized.

Hasse, Lee, and Banks (1979) employed the constructs of Polychronicity and Monochronicity to describe an individual's ability to handle stress stemming from stimulus-intense information overload. The construct regards the degree of order, regulation, and structure which one applies or requires in a situation to be indicative of a poly- or monochronic coping style. Characteristics of these constructs are presented below.

Monochronicity	Polychronicity
Structure required	Flexible; little need for structure
Unable to assimilate new information rapidly	Able to assimilate new information rapidly
Less tolerant of ambiguity	Tolerant of ambiguity
Low degree of distress from information overload	High degree of distress from information overload
Select specific stimulus from complex situation	Employ multiple dimensions leading to longer time and greater effort to arrive at choice or solution

Hasse et al., in developing an Index of Polychronicity, supported its construct validity via two factor analyses, yielding five orthogonal and interpretable factors termed: Information Overload, Interpersonal Overload, Change Overload, Activity Structure, and Temporat Structure. To test the validity of the construct, Index scores were compared to the Otis-Lennon measure of intellectual functioning and to the Bieri Grid. The Polychronic-Monochronic designations were determined to relate to IQ and complexity, but were not seen as identical to either. However, the authors suggest that further investigation could relate their concepts more directly to cognitive complexity or cognitive style.

Several attempts have been made to correlate Witkin's construct of field independence with integrative complexity: all with limited success. The tool most often used in such studies is the Embedded Figures Test (Witkin, Goodenough, and Oltman, 1979). It is believed that one reason for the low correlations between scores on this test and those obtained on complexity measures is the purely perceptual nature of field independence/dependence construct and measurement tools.

Greater relationships among measures can be expected when they are designed to measure similar structural phenomena, whether or not

they were developed on the basis of the same theoretical constructs. Smith and Evans (1980) explored the relationship between two measures of that kind: the Rep, as a measure of cognitive differentiation; and a test of Constellatoriness, i.e., a measure to construe elements in a stereotypical and undifferentiated way. The measures are negatively related to each other and cannot be considered as distinct variables.

Measures of Performance

For the purposes of this section, a distinction among measures developed earlier and those developed in later years will not be made. Part of the reason for this approach is the rather small number of measurement techniques that are available and the limited set of theoretical approaches that have generated them. Another reason for the lack of distinction is the specific applicability of the measures to the present project. Separating the measures into distinct categories would, in this case, likely hinder communication.

Early work by Driver and by Streufert was based on the analysis of simulation procedures. Later efforts by Suedfeld added post hoc analysis measures to relate complexity to political performance in the "real world." Measures of performance have, in nearly all cases, focused on scoring complex decision making. Only recently have efforts by Streufert considered measurement in simpler performance tasks. In all of these research efforts, however, the perceptual social domain has been abandoned for executive social and executive non-social domains. In addition, the measurement efforts have a distinct applied character.

Early work by Driver (1962) utilized the Inter Nation Simulation of Guetzkow and associates to measure decision making characteristics of more or less complex decision makers. Environmental variation was not considered or was considered only in minimal terms. The

INS is a free simulation (c.f., Fromkin and Streufert, 1976) and consequently is not amenable to precise and controlled research (see Streufert and Swezey, 1980). Driver was forced to count the frequency of events occurring across a number of simulation runs and to calculate mean discrepancies from linear or curvilinear relationships among specified variables. Nonetheless, this method did produce a number of data sets which showed differences among decision making groups; and particularly, differences between teams of more complex decision makers and teams of less complex decision makers.

Decision Making Measures

1. Single Strategy Models

Articles previously discussed under the single strategy model section of the Decision Making portion of this review can be viewed as describing rules applied in decision situation and as suggesting hierarchies or orders of complexity with which the rules might be organized. They tend to relate the complexity level of the strategy with the characteristics of the situation or problem.

The characteristics of the problem tend to be treated as aspects of uncertainty, conflict, and/or complexity. The measurements at this level aim at attempting to determine whether certain strategies or rules are preferred, or used more often, or whether amounts of uncertainty, conflict, or complexity will predict the selection of a rule. Uncertainty has been tested to determine rules employed to reduce or cope with it. Gambling simulations are frequently used for this purpose, as they were by Larson (1980), and by Payne and Braunstein (1978). These situations were designed to measure the accuracy of prediction of specific models, and results are interpreted only in terms of the model's relative usefulness. Although they provided varying levels of uncertainty in their gambles,

there is little to be generalized from them in terms of complexity of the gamble, or how complexity in the gamble might have effected the decisions made. Perrault and Russ (1979), for example, provided subjects with a salesman evaluation situation, where subjects were asked to decide which of five salesmen should be paid a bonus, based on multiple attributes differing among the salesmen. It was determined that the lexiocographic (see our earlier discussion of this model) levels of rules were employed in complex situation. The lexiocographic styles of decision rules were identified as being more complex, requiring more information, and requiring more time and effort.

Payne (1976) improved this situation by adding an explicit information search requirement to his apartment selection decision. Using both the information search and verbal protocol tracing methods, Payne found that selected rules changed when the situation changed from a two-alternative level to a more complex multialternative task. However, he interpreted the change as one which provided for simple, quick elimination of alternatives, and reported use of only limited amounts of information. Payne did not report an identifiable difference in complexity of the situation.

Christensen-Szalanski (1978) defined and described strategies as higher in complexity or lower in complexity. He used a financial problem where subjects were asked to predict outcomes and also to report which of the defined strategies best described their decision making methods. In this work, complexity level of the chosen strategy was contingent upon the complexity of the situation. Unfortunately, although it was recognized that decision maker characteristics bear heavily on selected techniques, the subjects in this study were deliberately homogeneous, which eliminated any information about the decision maker effects.

2. Multi-stage Models

The single strategy decision making models have assumed that a "best" rule applied in a situation, although the rule might consist of several steps. The multi-stage approach assumes that strategies consist of sets of rules, as opposed to sets of steps within a rule. Measures at the multi-stage level attempt to demonstrate conditions which produce a particular strategy, and conditions which produce changes in the levels of strategy complexity. As Park (1978) suggested, they attempt to describe the whole process rather than the specific choice mechanisms.

Park identified two strategy levels: a conditional elimination-simplifying-evaluation process, which was displayed first, and was followed by a second stage, a "satisficing plus" strategy (see earlier discussion). Park noted that at the first level, only crude cognitive categories were applied, while at the second level, the cognitive categories were refined on the same product dimensions. Park provided insight into models which might be applied to multidimensional decisions (Elimination by Aspects types, followed by Satisficing Plus types), but did not provide the connection needed to the cognitive structure or style of the decision maker.

Olshavsky (1979) based his work on Park's model and probed further to determine the validity of Park's contingency assumptions, and to identify experimentally the effects of the number of dimensions on complexity of the selected strategy. Olshavsky's results partially confirmed Park's observations, but found that more time was required to reach decisions in the more complex conditions. This would tend to confirm the assumption that a cognitively complex person actually processes a greater volume of information, and produces fewer decisions

per unit time, than does the person responding at lower levels of cognitive process. Olshavsky suggested that latency differences may have occurred at the perception level, but that other explanations (such as reading time for more attributes, and addition of extra cut-off levels, which also require time to implement) could be equally valid explanations.

Huber (1980) related strategy production to cognitive process. Huber employed the concept of Elementary Information Processes which was defined as constituents of the decision maker's general problem-solving repertory, or the "vocabulary" from which varieties of strategies are formed. This approach has some similarity to the complexity concept, but is limited to types of skills used. Interestingly, Huber found that skill implementation depended directly upon task variables.

Streufert and Streufert (1981) have recently consolidated their theoretical position into the establishment of nine categories or "styles" of decision making. These categories follow.

Category 1: The low unidimensional decision maker. On the average, this person uses a categorical (e.g., good vs. bad) judgment in response to a stimulus. Degrees of judgment (e.g., A is better than B, but not as good as C) are rarely, or never, available. The dimension utilized is usually the same with regard to nearly all stimulus situations, but could occasionally vary with the domain employed.

Category 2: The normal unidimensional decision maker. This person utilizes a single dimension in response to any particular stimulus, but can easily consider "shades of gray" (i.e., discrimination of points along one dimension). If different dimensions are employed for different stimulus situations, the person is probably not aware that he or she is utilizing different dimensional judgments (e.g., utility in a business stimulus setting; good vs. bad in a religious setting, etc.)

Category 3: The general differentiator. This person does (with awareness employ two or more dimensions in response to a single stimulus (or stimulus set), but either views these dimensions as non-interrelated (e.g., a person is like this when A happens and like that when B happens), or such a differentiator would pick and choose one of the dimensional outcomes for his or her actions. In other words, integration does not take place except in extremely limited situations.

Category 4: The closed-hierarchial-differentiatior. We are here combining the effect of closedness with the process of hierarchial information processing (the absence of processing flexibility). While the processes involved are oblique, they are not necessarily so widely separated in the decision making process to justify independent categories. Hierarchical processing of information from input to output (perception to decision making) suggests

that a set of relationships has been learned, or is otherwise given, that determines the outcome in advance. For example, the process may say "if event A occurs, it may be responded to by either X or Y. Which of the two is appropriate depends on the simultaneous occurrence or nonoccurrence of B."

Closedness indicates that the pre-learned process is not, in-and-of-itself, subject to modification. Relearning of a new process would have to follow the same pattern of learning that was established when the initial acquisition took place, or would at least, require major (probably negative reinforcement) impact experiences.

The closed hierarchial differentiator, then, employs two or more dimensions in response to a single stimulus, dimensions that are predetermined and that have predetermined characteristics or rules governing which dimensions are selected.

Category 5: The excessive differentiator. Differentiation into finer and finer sub-dimensions can take place nearly *ad infinitum*. Some decision makers tend to generate an inordinate number of alternative possibilities of responding, consequently responding very late or not responding at all. Integration does not take place at all for such persons.

Category 6: The low level integrator. Developing beyond the general differentiator, the low level integrator is able to close (for decision making) and reopen (for reconsideration or for additional decision processes). Such a person will differentiate incoming information, i.e., view a stimulus on more than one dimension, as the differentiator did, but will see no need to make a decision choice based on only one of these dimensions. Rather, some superordinate concept (dimension, etc.) may be used to combine outcomes from the two separate dimensional judgments into a single decision output (or several related outputs).

Category 7: The high level integrator. As in Category 6, flexibility to be open, to close, and to re-open is again given. The difference here is the number and interactive characteristics of the superordinate concepts that are used to relate the different "readings" from the various dimensions on which a stimulus is perceived. (Note that one of those superordinate categories may well be a time perceived consequence in the sense considered by Jaques, 1978).

Category 8: The closed hierarchial integrator. Again, we are combining closedness with hierarchial functioning (for the reasons listed earlier). Here, the decision maker has learned (or has otherwise determined) specific complex conditional statements in response to specific relationship between stimuli and decision outputs. He is using an (often weighted) complex branching technique to arrive at a fixed decision. He is not likely to re-open to reconsider his decisions or to alter his style in the face of input that does not quite fit preestablished patterns. Most likely such an input would be distorted to fit. Changes in the dimensional location of certain stimuli are likely to be rejected, particularly if they require a modification of several relationships in the hierarchial structure of conceptual relationships.

Category 9: The non-closing integrator. This person is simultaneously quite capable, yet decisively ineffective. The non-closing integrator is usually a flexible integrator with high level integrative capacity (c.f., Category 7), but without the ability to close temporarily for decision making. This is a person who generates an inordinate number of complex interpretations and decision potentials, taking a large number of concerns into account. Because he or she comes to so many different conclusions, none of which seems quite good enough (because there are still so many other things to consider and integrate), decisions will rarely be made. If they are made, they tend to span over long time periods (on the average).

Ongoing and Future Research

Suedfeld, based on the work of Schroder and Suedfeld, 1971 developed a method of scoring protocols for complexity of perception and complexity of communication. The scoring system is based on the procedures used in the Sentence (Paragraph) Completion Test of Schroder and Streufert (1962). Statements are scored for both differentiation and integration. All of these approaches (Driver, Streufert, Suedfeld) have been shown to have considerable predictive (or in the case of the work of Suedfeld, post hoc) validity.

Development of strategy and long range planning scores in complex experimental simulations was based directly on evidence of differentiation and integration among decisions and decision categories leading to strategic outcomes. In simple tasks, evidence of the (cognitive or performance related) differentiative and/or integrative processes is not directly observable, and scoring for strategic action per se is viewed as implicative of complex information processing (taking a number of cognitive dimensions into account when engaging in an action decision).

Recent efforts by Streufert and Streufert (1982) have led to the development of a simple hand-eye coordination task which allows for strategic behavior. The task is based on a video game permitting the introduction of various levels of environmental complexity via difficulty levels manipulated on two separate variables. Subjects are forced repeatedly to make decisions about their future actions, permitting more or less strategic actions and reflecting more or less planning for the future. Scoring for complexity of performance in such a task is based on the utilization of strategy. In addition (and parallel to experimental simulation techniques), other measures (concerned, for example, with risk taking and with success in the task) can also be collected.

While the performance measures employed in simple tasks and in various complex tasks are reliable and have been shown to have predictive validity, they have not been correlated with each other. One such effort is currently underway. Complexity of performance in an experimental simulation (Streufert and associates) will be related to performance in the simple task described above. Performance on both tasks will be predicted from cognitive complexity scores on the sentence completion test and an objective measure which is currently under development. The research is not yet far enough advanced to estimate what the obtained levels of relationships might be.

SUMMARY

The most striking characteristic of theory, measurement, and research on cognitive and environmental complexity is the wide variety of approaches that have been and still are used to come to terms with structural dimensionality. A surprising (and comforting) aspect of these efforts is the considerable overlap in predictions _and_ in the actual data obtained. One can only conclude that the various approaches to cognitive complexity must tap somewhat diverse parts of a single or a widely overlapping phenomenon. Certainly, in the case of the concepts and measures of differentiation and integration this is clearly the case. But, apparently, the commonality goes much further.

Equally striking is the success in predictions for performance across a number of tasks and in a number of diverse settings (as long as multidimensionality is useful or required). A warning should, however, again be sounded: there certainly are many situations where the use of multidimensionality for either perception or performance may be inappropriate. The successful person, group, or organization should not only be able to differentiate and integrate, they should also know _when_ such efforts are likely to be useful and appropriate

and when they are not. The degree to which such knowledge, such an ability or such a style can be trained is still in question. We know that some training in a specific domain is possible. We do not know how long such training will continue to be effective, and we do not know whether or how it will spread from one specific domain to another. Some of the findings reported earlier in this discussion would suggest that training can be achieved at least in some domains under some conditions. Yet, since in only a few pieces of research, training has been explored, that conclusion must remain tentative. The finding that cognitive complexity, at least under conditions of arousal, relates differentially to physiological responsivity could suggest some greater differences between persons classified as cognitively complex and those classifed as less so. Only future research can resolve those concerns.

III. COGNITIVE COMPLEXITY MEASURES SELECTED FOR USE IN THE MANAGEMENT ASSESSMENT AND TRAINING SIMULATION SYSTEM

Streufert and associates (e.g., Streufert, Clardy, Driver, Karlins, Schroder, and Suedfeld, 1965) developed a series of controlled experimental simulations, designed to measure the effects of specific variables on performance. Selection of participants into homogeneous groups of more complex vs. less complex (e.g., Streufert and Schroder, 1965; Streufert and Driver, 1965) or into mixed groups (e.g., Stager, 1967) using the sentence (paragraph) completion test, permitted more precise measurement of performance across groups exposed to identical progressing environements. Development of experimental and quasi-experimental simulation techniques (c.f., Streufert and Swezey, 1980) justified the parallel development of a number of measures of performance which appear to be responsive to (a) changes in the complexity of the environment, and (b) differences in the cognitive complexity of decision makers. In the present circumstance, it also appears important to obtain measures of decision making _outcomes_ which may be affected by both presence and absence of cognitive complexity. The measure selected for utilization in the present situation, thus, are designed to cover all areas of decision making stylistics (both structural and content oriented) without overlap. This form of measurement provides the researcher with a wide range of insight into a person's, group's, or organization's style of decision making. The selected measures are

1. _Decision categories_. These are the number of categories that are viewed as independent by the decision maker. In the military, this may, for instance, be an infantry attack, calling in bombers, Naval shelling, etc. Comparisons based on the number of

decision categories used are meaningful only if (a) the resources are constant across decision makers, and if (b) training or knowledge (familiarity with the setting) is equivalent. Decision categories can be meaningfully measured in some simple and most complex tasks.

2. Spread across decision categories. Here the concern is with the degree to which a decision maker favors specific decision categories and rarely uses other categories. Again, the measure can apply to both simple and complex tasks.

3. Number of decisions. The number of (independent) decisions made per unit time. In some simple tasks, the number of decisions may be replaced by the number of actions.

4. Number of integrations. The number of relationships between decisions in different decision categories where one decision is used as the basis for another. Number of forward integrations reflects relationships where a decision at an earlier point in time is made to allow (in strategic sequence) for the possibility of the later related decision. Number of backward integrations reflects relationships where a later decision is based on a previous decision, even though the previous decision had been made for an unrelated reason. This measure is more useful in complex multidimensional tasks. Equivalent use of strategy measurement can be developed for some simple tasks.

5. QIS (Quality of Integrated Strategies). This measure is sensitive to the length (over time) of complex strategic planning in complex tasks, and to integration, and to the complexity (interactive multiplicity) of the strategies carried out over time. A time frame measure can be developed for simple tasks as well, although it tends to show little equivalence to the QIS measure.

6. Number of respondent decisions. The number of decisions which are made in direct response to information received. A sub-category, number of retaliatory decisions, reflects respondent decisions that reflect a 1:1 orientation to the information received. In this case, there is no use of the respondent (here, retaliatory) decision in any overall strategy. This measure is equally useful in both simple and complex tasks.

7. Characteristic response and response speed to information. The degree to which information received results in more respondent, or more differentiated/integrated decision making, and the average time taken from receipt of information to the response. The measure is useful in both simple and complex tasks.

8. Quality (if immediate response is required). Situations and information inherent in situations differ in the degree to which immediate responding is needed or unnecessary if success is to be achieved. Here the concern is with a situation in which only immediate responding is likely to lead to success (response adequacy). The measure is relevant in both simple and complex tasks.

9. Quality (if novel strategy is required). Situations that are unpredictable and in rapid flux require reconsideration of previous established patterns and re-adaptation to the changed environment. Here, concern is with the degree to which a decision maker can adapt to rapid and unexpected modifications of the situation and can respond appropriately to obtain an adequate success level. The measure is relevant to complex tasks and may be relevant to some simple tasks.

10. Quality (if learned pre-established strategy is required). Situations containing many components and contingencies that are relatively stable and allow a well-practiced, yet complex,

response pattern to a series of expected or familiar stimuli require the responses rated highly here. The measure is relevant to many complex tasks, and may be relevant to some simple tasks.

The following formulas reflect the decision processes and their measures as discussed above.

1. Decision categories:

$$\sum_{1}^{p} c$$

where

c = the number of categories employed,

p = any period of time of interest (e.g., a playing period in the simulation during which some variable was manipulated at a specific level).

2. Spread across decision categories:

$$\sum_{1}^{p} 2\,(d_{Ca} - d_{Cb}) + (d_{Cd} - d_{Ce})$$

where

d = the number of decision,

d_{Ca} = the number of decisions from the category or categories representing the upper ten percent of decision frequency,

d_{Cb} = the number of decisions from the category or categories representing the lower ten percent of decision frequency,

d_{Cd} = the number of decisions from the category or categories representing the remaining upper 40 percent of decision frequency, and

d_{Ce} = the number of decisions from the category or categories representing the remaining lower 40 percent of decision frequency.

3. Number of integrations:

$$\sum_{1}^{p} i_f \quad \text{or} \quad \sum_{1}^{p} (i_f + i_b)$$

where

i_f = the number of connections between decisions of one category with decisions of another category, reflecting pre-planning of the later decisions as the previous decisions is made as a (strategic) necessary antecedent to the later decision, and

i_b = the number of connections between a later decision of one category and an earlier decision of another category, where the outcome of the previous decision is used for the purpose of achieving the goals of the later decision, where the relationship between these decisions was, however, not planned when the earlier decision was made.

Which of the two integration measures is utilized (or whether both are utilized) should depend on the interest of the researcher or trainer/assesser; i.e., is strategic planning of interest or is general strategic behavior of interest.

4. Number of decisions:

$$\sum_{1}^{p} d$$

where

d = the number of decisions.

5. QIS (Quality of Integrated Strategies):

$$\sum_{1}^{p} W\,(1 + n_p + n_f)$$

where

W = the length of time dimension of any forward integration between the decision points connected by that integration,

n_p = the number of other forward integrations connecting to the decision representing the beginning point of the integration in question, and

n_f = the number of other forward integrations connecting to the decision representing the endpoint of the integration in question.

The number of integrations, n_p and n_f, here includes <u>all</u> forward integrations linked to a relevant decision point in chain sequences via several decision points (i.e., the linked decision points are part of a continuing strategic decision sequence).

6. Number of respondent decisions:

$$\sum_{1}^{p} r$$

where

r = any decision made within a given time period (depending on the speed, i.e., time compression, of the simulation) after the receipt of relevant information and made in direct response to that information.

7. Response speed:

$$\frac{\sum_{1}^{P} t_r}{r_p}$$

where

t_r = the elapsed time between information received and a subsequent respondent decision to that information, if such a response is made, and

r_p = the number of respondent decisions made during the time period from 1 to P.

8. Quality (if immediate response is required):

Measured by external criteria, e.g., ratings by experts or superiors.

9. Quality (if novel strategy is required):

Measured by external criteria, e.g., ratings by experts or superiors.

10. Quality (if learned pre-established strategy is required):

Measured by external criteria, e.g., ratings by experts or superiors.

Figure 2 relates this measurement approach to the nine decision making styles posited by Streufert, and Streufert (1981). Also, shown within cells are expected outcomes for various styles.

STYLE USED IN DECISION MAKING	1 DECISION CATEGORIES	2 SPREAD ACROSS DECISION CATEGORIES	3 NUMBER OF DECISIONS	4 NUMBER OF INTEGRATORS	5 QIS	6 NUMBER OF RESPONDENT DECISIONS	7 RESPONSE TO INCOMING INFORMATION	8 QUALITY IF IMMEDIATE RESPONSE IS REQUIRED*	9 QUALITY IF NOVEL STRATEGY IS REQUIRED*	10 QUAL. IF LEARNED (PRE-ESTABLISHED) STRATEGY IS REQUIRED*
LOW UNI-DIMENSIONAL	FEW	MASSED IN FEW CATEGORIES	MATCHING INCOMING INFORMATION	NONE	VERY LOW	HIGH	RESPONDENT, RAPID	MODER. BUT MAY RESPOND INCORREC. IF RESPONSE ISN'T IN REPERTOIRE	LOW	LOW
UNIDIMENSIONAL	FEW	MASSED IN CERTAIN GROUPINGS	MATCHING INCOMING INFORMATION	VERY FEW SHORT RANGE	VERY LOW	HIGH	RESPONDENT, RAPID	MODERATELY HIGH, MAY RESP. INCORR. OR INAPPROPRIATELY IF RESPONSE IS NOT IN REPERTOIRE	LOW	MODERATE
GENERAL DIFFEREN-TIATOR	MORE THAN ABOVE, SAME AS INTEGRATOR, SELF GENERATION, MORE EVEN SPREAD	MORE EVEN	AVERAGE	FEW SHORT-RANGE, FEW RESPONDENT DECISIONS ARE INTEGRATED	LOW	MODERATE	MODERATELY SLOW	MODERATELY HIGH TO HIGH	MODERATE	MODERATE
CLOSED HIERARCHICAL DIFFEREN-TIATOR	DEPENDS ON HIERARCHY	DEPENDS ON HIERARCHY	AVERAGE	VERY FEW, SOME PRE-DETERMINED RELATIONSHIPS	VERY LOW	MODERATELY HIGH	MODER. RAPID, POTENTIAL DISTORTION	HIGH	LOW	MODERATELY HIGH
EXCESSIVE DIFFEREN-TIATOR	MORE THAN ALL OTHERS	NO PREDICTION	FEW	VERY FEW SHORT RANGE	VERY LOW	MODERATELY LOW	SLOW	MODERATE (TOO SLOW)	LOW	MODERATELY LOW
LOW LEVEL INTEGRATOR (FLEXIBLE)	MODERATE	NO PREDICTION	AVERAGE, SOME EFFECT OF INFORMATION	HIGH SHORT-RANGE SOME RESPONDENT DECIS. INTEGRATED	LOW TO MODERATE	MODERATE	MODER. SPEED, MORE LIKELY INTEGRATED	MODERATELY LOW	MODERATELY HIGH	MODERATELY HIGH
HIGH LEVEL INTEGRATOR (FLEXIBLE)	MODERATE	MORE EVEN, DEPENDING ON STRAT. SEQUENCE GROUPINGS, MAY CHANGE WITH TIME	AVERAGE, LESS AFFECTED BY INFORMATION	HIGH-SHORT AND LONG RANGE, MANY RESPONDENT DECI-SIONS INTEGRATED	HIGH	MODERATE	MODERATE SPEED, INTEGRATED OR RESPOND., DEPEND ON PERCEIVED SITUATION DEMAND	LOW	HIGH	MODERATELY HIGH
HIERARCHICAL (CLOSED) INTEGRATOR	DEPENDS ON HIERARCHY	DEPENDS ON HIERARCHY	AVERAGE	MODERATELY HIGH, DEPENDS ON HIER. PRE-DETERMINED RELATIONSHIPS	HIGH PRE-DETERMINED RELATION-SHIPS	MODERATELY HIGH	MODER. RAPID, POTENTIAL DISTORTION	MODERATE	MODERATELY LOW	HIGH
NON-CLOSING INTEGRATOR	FEW, EXCEPT WHEN IN GROUPINGS	EVEN	LOW, EXCEPT IN GROUPINGS	FEW, BUT LONG-TIME RANGE AND CLUSTERS	MODERATE DUE TO VALUE OF W	LOW	DELAYED NON-RESPONDENT	LOW	LOW	LOW
MEASURE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (TIME ONLY)	JUDGMENT BY EXPERTS OR PARAMETER	JUDGMENT BY EXPERTS OR PARAMETER	JUDGMENT BY EXPERTS OR PARAMETER

*ASSUMING EQUIVALENT KNOWLEDGE, TRAINING, OTHER SKILLS, ETC.

Figure 2. Decision Styles by Measurement Technique Matrix

IV. ADDITIONAL APPROACHES AND MEASUREMENT TECHNIQUES SELECTED FOR POTENTIAL USE IN THE MANAGEMENT ASSESSMENT AND TRAINING SIMULATION SYSTEM

It is currently the intent, in developing the Management Assessment and Training Simulation System, to provide for the collection of information from users on three additional construct measures, if feasible. These measures, which are briefly discussed in order below are Level Abstraction, Simultaneous Information Processing, and Subjective Psychological Load.

Level of Abstraction

Characteristics of individuals, as presented by the social sciences, are typically depicted as a quantitative expression of continuity in the form of a normal curve. The implication of such a distribution is that one is describing a single parameter of a psychological or social phenomena. Multiple parameters, or discontinuity, as expressed by multi-modal distributions, is a less common approach, and one which may include the characteristic of cognitive abstraction and associated behavior as the capacity to do work. A large number of theoretical and research papers have been published on this topic by Jacques and his coworkers (c.f., Jacques, Gibson, and Isaac, 1978; Rowbottom, 1977; Jacques and Stamp, 1981).

Based on a variety of quantitative and qualitative research in the areas of organizations and human capacity, a number of levels of abstraction or capabilities (originally five, then extended to seven by later work) are hypothesized by Jacques and associates to be a fundamental cognitive characteristic of people. These levels of

abstraction are said to range from concrete ideation and performance at the lowest level to higher levels of human functioning addressing classes of classes or infinite sets within ideations. Essentially, human cognitive development is perceived to occur in stages which are discontinuous, thus dividing the population into multi-modal distribution groups.

Evidence, on the establishment of five levels of abstraction, with the addition of two further levels, have been generated by the study of people functioning (i.e., working) in organizations. More recent research has suggested the existence of six and seven levels by an analysis of work within bureaucratic hierarchies (Jacques and Stamp, 1981). These higher levels require individuals to intermesh a wide range of disciplines across a variety of environments extending from a local level to an international one. Researchers in the area of levels of abstraction note the possible existence of more than five levels, but have not been able to classify them nor obtain enough evidence of their existence. The discussion that follows, therefore, will be primarily limited to the original five levels, however, levels six and seven will be presented where appropriate.

Level One: The primary emphasis is on concreteness. Activities are prescribed and performed according to strict rules and procedures. Human performance is dominated by a process of operations on objects, or generally referred to as a skill. The situation or environment where these skills are performed, based primarily on intuition of the individual, is dominated by a high level of uncertainty.

Level Two: Behavior and ideation at this level is hypothesized to result from an increasing degree of ambiguity as evidenced by incomplete prescriptions, rules, and procedures. The ambiguity of the environment is perceived by an individual as having a flexible rule system where inductive thought processes can be used to complete objectives in a relatively concrete situation.

Level Three: Increasingly introduced at this level is use of systematic thinking and performing. The environment is characterized by an increased certainty as perceived by the individual, allowing behavior to occur in serial form. The ideation of an individual allows for extrapolation from specific instances to those more general.

Level Four: Cognitive activity becomes more abstract leading to hypothesis testing and innovation. Generalizations begin to be made on the basis of a few concrete examples, with a concomitant increase in uncertainty.

Level Five: Theory construction and general rule making become firmly established at this level, across a wide spectrum of domains. The environment is related to an intuitive, inductive way, which increases the uncertainty of what is known of the universe.

These levels of abstraction have been formulated through the observation of people performing or behaving at a variety of levels within organizational hierarchies. From these observations, researchers in this field have hypothesized that work behaviors are probably reflective of a distribution of the capacity to do such work. There further appears to be a universality of these observations in the form of a discontinuous distribution of these capacities.

Within each level of functioning, people are thought to function according to a dominant mode of operating. The dominant mode of operating is further thought to interact with existing, but less dominant modes. Modes of operating, those that are dominant and those less so, are also discontinuously distributed within each level of abstraction or work-capacity stata. Further, operational modes increase in number at successively higher levels of abstraction, with a maximum of five modes operating at the fifth level. These modes are briefly presented below.

Mode one: competent, persistent, attention to detail (i.e., proceduralists or pragmatic specialists)

Mode two: pragmatic, organizational ability - self and others (i.e., practioners or pragmatic generalists)

Mode three: information gatherers and organizers, planning ability, effective use of personnel (i.e., system setters or theoretical generalists)

Mode four: intellectually able, creative, subtle, excelling in research and staff consultancy roles (i.e., structuralists or theoretical specialists)

Mode five: originality in approach to problem solving, routine work not consistent with this level (i.e., originators)

Within each level, therefore, evidence seems to exist to indicate only mode one is operating at level one; modes one and two operating at level two; and so on, through the five modes operating at level five. While people will predominately function in one specific mode within a level, operating modes will fluctuate in response to a particular problem, or change as a function of a temporary individual characteristic, such as a mood. For example, an individual who predominantly works as a system setter (see mode three) at level four, may, for a particular task, function in a very concrete mode (see mode one) relative to the other three modes at this level. Operating modes and levels are hypothesized to form a full system of work capacity into five levels within 15 components (modes) within the levels.

Related to both the level an individual is working on within an organization and that person's capacity to do work, is the temporal frame within which a person can plan and execute specific, goal-directed activities. This temporal frame is thought of as a cognitive ability as well as a requirement of one's position within an organizational hierarchy. The extent or quantity of a person's work capacity is time related. The farther forward in time an individual is able to plan and formulate goals, progress, and carry them out to

completion, the greater than person's capacity. The research in levels of abstraction have suggested that a temporal frame exists that has cut-off points at three months, one year, two years, five years, and ten years. These time bands correspond to the five levels of abstraction in human mental activity. As mentioned earlier, the levels may be extended to a sixth and seventh strata, with a temporal cut-off of 20 years. The cut-offs correspond to each level, such that:

Time Span	Level
20 years	7
10 years	6
5 years	5
2 years	4
1 year	3
3 months	2
	1

It has been suggested that the level of abstraction and its level of extension of context, or temporal cut-off, at which a person functions is correlated with the maximum temporal frame with which the individual can cope. While all modes are used within a given level by a person, only one mode will be dominant and tend to be dominant for a particular person. A qualitative distinction can be made of the modes in relation to time span. The more concrete modes are based more on past experience and the more abstract modes are based more upon future developments. Modes, therefore, provide an interplay between organized experience and future contexts. An individual can move from dominance of one mode to that of another as the need to rely directly upon concrete experience or future goals in solving a particular problem.

The levels of abstraction theory posits that the very ability which allows an individual to handle the higher levels of abstraction is the same ability which enables him to plan and work longer into the future, to take on and to successfully plan and progress longer projects. In other words, this ability allows a person to line and act within a more extended temporal frame.

Jacobs (1981) has attempted to operationalize these levels for the Army hierarchy. Jacobs' interpretation of the levels are briefly presented below.

I -- Concreteness. At this level, the individual is concerned with specific shop floor tasks. The worker would be given a specific item to build and would be given an example (i.e., build me one of these). For someone doing data collection, specific interview questions would be provided (i.e., ask this question).

II -- Coping with tasks with ambiguity. At this level, the individual will be given a job but without the exact example, or will be told to do, but with the notion that adaptation may be required (e.g., in manufacturing: I want 1000 of these per week. Supervisor may decide this week to do 850 because of problems, and then to catch up next week with 1150 or 1200 or so.) For an interviewer, broader latitude would be given to collect information by either developing one's own interview schedule or one's own probing questions. MILITARY: Mission type orders. This occurs first at company level.

III -- Trend extrapolation. This is the first level of systems functioning. The individual at this level is aware of the world of trends, and adapts to the future through extrapolating trends. Example: Departmental manager who monitors shifting load vs. resources and people. He anticiaptes needs for tools, etc., may manage 250-300

people in industry. MILITARY: Probably at battalion level. This is the first level at which a commander will tailor a task force for a combat mission. The underlying dimension is the capability to tailor combat power. The commander has learned from experience in coping with mission requirements, operating the system.

IV -- Jump logic. Here, trends no longer work. The individual must be able to handle extrapolations of trends, but must also be able to construct a world in terms of what is missing. This is the level at which the first real creativity occurs. Industrial example: Design some jigs and fixtures for me to improve procedures. The incumbent says, "No. That is not the way to do it. You can't get there from here." He then starts all over with a new process and breakes the old trend because the old trend would not extrapolate to cover the new conditions. The new process is a quantum jump. Example: Get more secretarial efficiency by harder driving, etc., in the face of manpower survey people who define upper limits of secretaries to basics, and the increasing flow of secretaries to headquarters levels in lower ratios. Break the system trends by going to word processors with many terminals, so scientists who can type can put the information in the word processor, and the secretary can then do the manipulation to format and print without having to type the whole thing from scratch. Editing functions could be shared. MILITARY: Colonel (and brigade) is the first level at which there is real experimentation with tactics -- discontinuous alternative means for doing missions.

V -- Open-ended top. The context within which the individual works is no longer fixed. It is open. The individual now has a concern with strategic considerations. Industrial example: The incumbent is asking questions such as, "What business should we be in?" or "What product should we have?" (as opposed to how much of a specific product). At this level, the individual will be managing subsidiary companies of

different types, e.g., aluminum, trucking, etc., as trading entities. At this level, for the first time the individual makes, and is expected to make, strategic input to seniors so as to assure that operational purposes at his own level can be accomplished. MILITARY: The Major General (Division Commander) will be the first level at which the commander suggests the strategic implications of operations, and participates in the formulation of operations, at least partly, in terms of how operations and more general strategy interact.

VI -- Transition to constructs being social systems. This is the level of corporate executives who practice "hands off management." Types of concerns at this level are vertical integration, for example. Individual sub-entities are managed without regard to the technical content of their operations. The strategic planning at this level must be such that it gives level V companies room to operate. Types of decisions: For an iron company as a subordinate entity: Should that company go into pellitizing, or should the conglomerate go into steel manufacturing and do the entire operation in one place? MILITARY: This is the corps commander, and it is at this level, for the first time, that one finds the integration of joint service operations, and the conceptualization of the "air-land battle."

VII -- Transition to extrapolating social, technical, and political systems as they relate to the future of the organization. MILITARY: The interfacing of CSA with the Congress.

Both complexity theory and the work on levels of abstraction address and make predictions about people's behavior based on the study of individual differences. Essentially, people develop and perform in their environments in consistent ways. The individual's perception of the world, as mediated by cognitive functions, allows him to function in a variety of circumscribed ways. Complexity theory

examines the individual variables as interactive elements within a complex environment. Variables within the environment, therefore, are seen to influence a person's performance or behavior by either being harmonious or discordant with a person's cognitive functioning. Multidimensional styles are able to function in an integrative fashion when task and environmental variables are conducive to such functioning. Increases or decreases in environmental complexity, such as information load, can reduce integrative behavior to that closely resembling respondent performance. With information load stabilized, specific tasks require a certain style of behavior, independent of the innate or learned cognitive functioning of the person. More cognitively complex individuals attempting a simple, unidimensional task may not perform as well as (i.e., as efficiently) as a less cognitively complex person. The work on levels of abstraction, however, seems to minimize the complexity of the environment. Rather, in this discipline, an individual cannot perceive the world from any other level of ability other than the one he is functioning on. Some problems may require analysis of the situation into so many details as to go beyond the potentialities of persons of lower levels of capacity. Under such circumstances the person feels overwhelmed by the problem, becomes disorganized, and inevitably fails.

Time-span has been hypothesized to be a measure of work in the levels-of-abstraction literature. The more an individual can focus further into the future in terms of planning and progressing toward a goal, the higher capacity for work or the higher level of abstraction he is working on. Complexity theory presents a somewhat analogous concept of multidimensionality and integrative processing. Multidimensionality depends on the numbers of dimensions in the cognitive domain and the degree if discrimination of these dimensions. Integrative processing reflects how dimensions are related within a cognitive domain. The greater number of dimensions an individual perceives within his environment, the more multidimensional he is. The greater

the number of perceived relations between these dimensions, the more integrative an individual is. Combining multidimensional processes with integrative processes leads to greater cognitive complexity. Greater cognitive complexity could possibly be in part equated with the higher levels of abstraction, and conversely, low cognitive complexity may correspond somewhat to low levels of abstraction. In simple one-to-one responding, information input is directly translated into a behavioral output (i.e., respondent decision making). Respondent behavior occurs more frequently with persons of more unidimensional structure and generally under less than optimal environmental conditions. At the first level of abstraction, where time-spans are below three months, tasks are assigned in concrete terms and carried out in direct physical contact with the output. If there is no immediate perceptual contact with the output, no work is done at this level.

Differentiated responding, according to Complexity Theory, requires a stimulus to be perceived on a number of different dimensions, and requires a response on several of these dimensions simultaneously (or subsequently) within a limited period of time. These responses, however, are not usually related to each other via some plan or strategy. Finding corresponding levels of abstraction which are analogous to more cognitively complex strategies becomes difficult because the complexity of the environment is minimized in the former, and is integral to the latter. However, the third level of abstraction involves imaginal scanning and aspects of behavior at this level may possibly be experienced by the differentiated individual. At the third level, time-span limits are seen at one or two years, where it becomes impossible physically to oversee or to imagine all at once the whole of a person's area of responsibility. The scope of activity has become too wide for this, although it still is possible to do so by mentally scanning the whole, one bit at a time. The instructions at this level tend to be in conceptual terms of load data, programs,

indices, etc. The interplay between project and output, therefore, has become qualitatively more complex. Feedback is in terms of comparing what is happening in various parts of the output region with equivalent parts in various parts of the subjective project.

Integrated responding implies, for complexity theory, that a number of cognitions based on various dimensions occur resulting in one or more responses which are related to each other in a planned or strategic fashion. This kind of response is most often seen in persons who are multidimensional integrators, and occurs with greatest frequency under moderate (i.e., optimal) information load conditions.

Possibly juxtaposed to the integrative decision makers is the fifth level of abstraction. At this level, a five to ten-year time-span is hypothesized. There is no possibility of having other than limited contact with the concrete reality of the total field of responsibility. The person operating at this level would be preoccupied in longer range futures. The cognitive activity at the fifth level is one of intuitive theories built up from experience. Specific experiences are generalized and absorbed for use as part of a general formulation of decision making.

A more superficial analogy can be made between these theories in terms of temporal perspective. For example, in complexity theory, maximum response levels can be reached by any organism (although this will vary by organism) in a specified time within which responses must be made. Because respondent behavior is made on the basis of a simple input to response relation, more respondent behavior can be expected in a shorter time. Integrative behavior, requiring greater cognitive effort, using larger numbers of information items, would be expected to take longer. Correspondingly, low levels of abstraction require shorter time frames because of the nature of the work; a simple

one-to-one correspondence. Higher levels of abstraction require greater capacities to process a more diverse information, and consequently, necessitate longer time frames.

Measurement

Goodman (1967) has operationalized measures for use in assessing Jacques' constructs. Two of these measures, anticipated for use in the Management Assessment and Training Simulation System, are

a. Time Span of Multiple Task Roles.

1. Considering your job as a whole, how far does your job permit you to plan ahead? (Write in time, e.g., 1 day, 2 weeks, 4 months, 3 years.)

   ..... average time

   ..... longest time

2. For some decisions, we learn about the results of the decision right away, for others, we must wait for the results. Considering your job as a whole, what is the

   ..... average time

   ..... longest time

   you must wait before you learn the results of a decision that you made.

b. Levels of Abstraction.

Jobs differ in terms of how much time they require the individual to spend on planning for certain activities and actually doing certain activities. What percent of your time do you spend on

..... % planning activities

..... % doing activities

100%

Simultaneous Information Processing

Sternberg (1981) has identified four approaches to understanding mental abilities: cognitive correlates, which relates test performance to tasks believed to tap basic information-processing abilities; cognitive components, which constructs cognitive process models of tasks from standard psychometric tests; cognitive training, which trains individuals in a particular skill, and examines subsequent performance; and cognitive contents, which examines the differences in knowledge structures between experts and novices. The major implication of these approaches is that they can relate test performances to specific mental processes.

In the cognitive correlates approach, according to Sternberg, subjects are required to perform tasks that are believed to measure basic human information processing ability. Here, information processing is generally defined as the sequence of mental operations and their products involved in performing a cognitive task. Such tasks include, among others, the Posner and Mitchell (1967) letter-matching task, in which subjects are asked to state as quickly as possible whether the letters in a pair, such as "A a," constitute a physical match (which they do not), or in another condition, a name match (which they do); and the S. Sternberg (1969) memory scanning task.

As reviewed by Chiles (1978) and by O'Donnell (1975), in the so-called "Sternberg task" the basic approach is that a user is required to learn a set of positive stimuli (so-called because their appearance calls for a positive response). Members of the positive set, frequently letters of the alphabet, are presented one at a time: generally, on half of the trials the stimulus is a member of a negative set. On the appearance of a letter, the operator is instructed to respond as quickly as possible by depressing a "yes" key if the letter is a member of the positive set and a "no" key if it is a member of the negative

set. Under appropriate conditions, a linear relation exists between the size of the positive set (typically 1 to 8) and reaction time. The psychological theory behind the use of this taks is that average reaction time with a given number of stimuli in the positive set can be broken down into three parts: (1) stimulus encoding, (2) memory scan, and (3) response selectior and execution. For a given set of conditions, the first and third parts are assumed to be constant, whereas the second part is interpreted to be a direct reflection of memory scan speed and/or memory load. Thus, changes in the y-intercept value (i.e., the response time for the primary task alone) are assumed to reflect changes in the perceptual and/or response aspects of the task. Changes in the slope of the curve are assumed to reflect changes in the rate at which memory is scanned and/or the amount of memory load involved. In other words, the y-intercept value serves the same function as a measure from a secondary -oading task as described previously; the higher the intercept (i.e., the longer the average response time), the greater the assumed loading produced by the primary task. In addition, a change in the slope of the response-time curve might be interpretable as a reflection of the amount of memory load added by the primary task. The value of this task as a loading task in the usual sense has been borne out by the results of preliminary studies conducted thus far. However, relationships with complexity theory are yet to be demonstrated.

If feasible, this technique, or a modification thereof, will be considered for use in the Management Assessment and Training Simulation System.

Subjective Psychological Load

Measurement of psychological load is an important aspect in the study of managerial decision making. The Cooper-Harper (1969) technique (see Ellis, 1978) is probably the premier technique for subjective

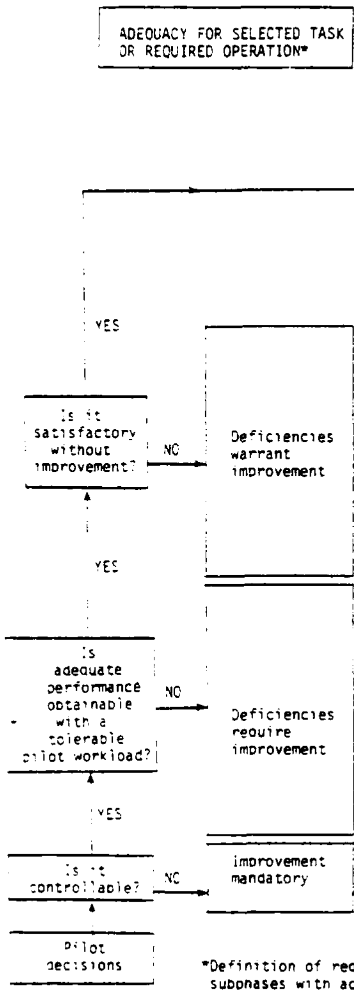
assessment of this construct, whereas the Sternberg technique (see above) purports to measure it more objectively.

According to Ellis, the Cooper-Harper rating scale was developed to assess handling qualities of aircraft and is such an important scheme for subjective assessment of psychological load that it is widely accepted as the standard scale for such purposes.

Cooper and Harper's scale is reproduced in Figure 3.

Spyker and colleagues (1971) have modified this technique to obtain subjective ratings on their workload experiments. The subjects were presented with a series of six questions and were asked to indicate an answer to each one by choosing one of a limited number (5 to 9) of phrases describing opinions: each answer was allocated a numerical value that corresponded to the position it would have on a scale of the Cooper-Harper type. Two of Spyker's sets of questions and answers are shown in Figure 4.

According to Ellis (1978), if a rating scale for workload is to be successful, it is likely that it will have been constructed along lines similar to those of the Cooper-Harper scale. Of course, the Cooper-Harper scale has been used in connection with workload measurement, and so the question arises whether it is an adequate scale for workload rating. The answer was provided by Geratewohl (1976). "Although workload is seen as inextricably tied to the assessment of such characteristics as compensatory system monitoring and precision of control, judgements of perceptual or mental effort involved in this process are generally not obtained. Hence, subjective ... ratings of handling qualities, as accurate as they may be in regard to control desirability or difficulty, do not contribute to workload determinations, since they are only loosely connected to task demands."



AIRCRAFT CHARACTERISTICS	DEMANDS ON THE PILOT IN SELECTED TASK OR REQUIRED OPERATION*	PILOT RATING
Excellent Highly desirable	Pilot compensation not a factor for desired performance	1
Good Negligible deficiencies	Pilot compensation not a factor for desired performance	2
Fair - Some mildly unpleasant deficiencies	Minimal pilot compensation required for desired performance	3
Minor but annoying deficiencies	Desired performance requires moderate pilot compensation	4
Moderately objectionable deficiencies	Adequate performance requires considerable pilot compensation	5
Very objectionable but tolerable deficiencies	Adequate performance requires extensive pilot compensation	6
Major deficiencies	Adequate performance not attainable with maximum tolerable pilot compensation; controllability not in question	7
Major deficiencies	Considerable pilot compensation is required for control	8
Major deficiencies	Intense pilot compensation is required to retain control	9
Major deficiencies	Control will be lost during some portion of required operation	10

*Definition of required operation involves designation of flight phase and/or subphases with accompanying conditions.

Figure 3. The Cooper-Harper (1969) Scale (from Ellis, 1978)

II. In my opinion control over the simulated aircraft was:

- ☐ Extremely easy to control with excellent precision (0.5)
- ☐ Very easy to control with good precision (2.5)
- ☐ Easy to control with fair precision (4.5)
- ☐ Controllable with somewhat inadequate precision (6.5)
- ☐ Controllable, but only very unprecisely (7.5)
- ☐ Difficult to control (8.0)
- ☐ Very difficult to control (8.5)
- ☐ Nearly uncontrollable (9.0)
- ☐ Uncontrollable (10.0)

III. In my opinion the demands placed on me as the pilot were:

- ☐ Completely undemanding, very relaxed and comfortable (2.5)
- ☐ Largely undemanding, relaxed (3.5)
- ☐ Mildly demanding of pilot attention, skill, or effort (5.5)
- ☐ Demanding of pilot attention skill or effort (6.5)
- ☐ Very demanding of pilot attention, skill, or effort (7.5)
- ☐ Completely demanding of pilot attention, skill, or effort (8.5)
- ☐ Nearly uncontrollable (9.0)
- ☐ Uncontrollable (10.0)

Figure 4. Spyker et al.'s (1971) Adaptation of the Cooper-Harper Technique

The following points, however, have been noted by Ellis (1978) about this approach.

a. The scale is more than one of pure comparison. Whereas a user can be expected to place a number of stimulus (configurations) in order of desirability, his Cooper-Harper rating for any of them is intended to be repeated whatever the qualities of the other configurations under assessment. Thus, if one example is given a rating of 4 in an experiment where all others lie between 6 and 8, it should also be rated 4 if its rivals were to lie between 1 and 3.

b. Despite this, the scale is essentially a comparative one and so does not present the user with an unreasonably difficult task.

c. The user is drawn towards the eventual rating through a step-by-step process. The value judgments that he makes are presented as a series of decisions. The dichotomous choices at each stage of the decision "tree" are fairly simple, and once the stimulus configuration under assessment has been placed within the value "boundaries" the user has to choose one of only three values.

d. The scale is aimed towards the practical application of the configuration under assessment. The user's judgments are all made in the context of the defined task.

e. The Cooper-Harper rating does not provide a complete assessment. It gives a merely shorthand guide to the load configuration.

f. The scale is very practicalbe. Once learned, it is easy to use and so it is suitable not only for laboratory experiments but also for user-oriented conditions. A user can give a rating and

make a few cryptic comments while he is performing a task, a circumstance in which he cannot be expected to go through an assessment ritual that is long and complicated.

g. The Cooper-Harper scale uses workload in a very specific, but limited manner. Workload is always related to the task; overall workload is judged against a standard of tolerability ("Is adequate performance attainable with a tolerable workload?) Other workload decisions are based on the concept of compensation (compensation is defined as "The measure of additional effort and attention required to maintain a given level of performance in the face of deficient stimulus characteristics").

h. The scale is ordinal. Naturally enough, researchers would prefer the scale to be a linear or interval one, and so have criticized it. Nevertheless, the construction of a practical scale of demonstrated linearity has not yet been achieved, and the many advantages of the Cooper-Harper outweigh its disadvantages. Some researchers take means and standard deviations of Cooper-Harper ratings, and although it might be convenient to express results in this way, caution should always be exercised when manipulating the numbers derived from this scale. For example, an average rating from a number of users might obscure the fact that one of them gave a much lower (or higher) rating than the others. The reasons for this isolated result may be simple, but should not be ignored.

If feasible, a modification of this approach will be designed for use in the Management Assessment and Training Simulation System.

REFERENCES

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Anderson, N. H. and Barrios, A. A. Primacy effects in personality impression formation. Journal of Abnormal and Social Psychology, 1961, 63, 346-350.

Arnett, M. D. Least preferred co-worker score as a measure of cognitive complexity. Perceptual and Motor Skills, 1978, 47, 567-574.

Asch, S. E. Forming impressions of personality. Journal of Abnormal and Social Psychology, 1946, 41, 258-290.

Attneave, F. Applications of information theory to psychology. New York: Holt, 1959.

Atwood, M. A. and Swezey, R. W. Microprocessor considerations for a management assessment and training simulation system. (SAI Technical Memorandum 178-81-1) McLean, VA: Science Applications, Inc., 1981.

Baudhuin, E. S., Swezey, R. W., Foster, G. D., and Streufert, S. An empirically derived taxonomy of organizational systems. (SAI Report No. SAI-80-091-178) McLean, VA: Science Applications, Inc., 1980.

Beagles-Roos, J. and Greenfield, P. M. Development of structure and strategy in two-dimensional pictures. Developmental Psychology, 1979, 15, 483-494.

Bell, R. C. and Keen, T. R. A statistical aid for the grid administrator. International Journal of Man-Machine Studies, 1980, 13, 143-150.

Bhutani, K. A study of the effect of some cognitive and personality factors on attitude change. Indian Educational Review, 1977, 12, 50-60.

Bieri, J. Cognitive complexity-simplicity and predictive behavior. Journal of Abnormal and Social Psychology, 1955, 51, 263-268.

Bieri, J. Complexity-simplicity as a personality variable in cognitive and preferential behavior. In D. W. Fiske and S. R. Maddi (Eds.), Functions of varied experience. Homewood, IL: Dorsey, 1961.

Bieri, J. Cognitive complexity: Assessment issue in the study of cognitive structure. Unpublished manuscripts, 1965.

Bieri, J. Cognitive complexity and personality development. In O. J. Harvey (Ed.), Experience, structure, and adaptability. New York: Springer, 1966.

Bieri, J. Cognitive complexity and judgment of inconsistent information. In R. P. Abelson, E. Aronson, W. J. McGuire, T. M. Newcomb, M. J. Rosenberg, and P. H. Tannenbaum (Eds.), Theories of cognitive consistency. Chicago: Rand McNally, 1968.

Bieri, J., Atkins, A. L., Briar, S., Leaman, R. L., Miller, H., and Tripodi, T. Clinical and social judgment: The discrimination of behavioral information. New York: Wiley, 1966.

Bruch, M. A., Heisler, B. D., and Conroy, C. G. Effects of conceptual complexity on assertive behavior. Journal of Counseling Psychology, 1981, 28, 377-385.

Chandler, M., Siegel, M., and Boyes, M. The development of moral behavior: Continuities and discontinuities. International Journal of Behavioral Development, 1980, 3, 323-332.

Chiles, W. D. Objective methods. In Assessing Pilot Workload, AGARD, 233. NATO: Neuilly Surseine, France, February 1978, pp. 54-77.

Christensen-Szalanski, J. J. Problem solving strategies: A selection mechanism, some implications, and some data. Organizational Behavior and Human Performance, October, 1978, 22(2), 307-323.

Cioata, E. Relationship between cognitive complexity and integrative constants of personality: Emotional stability and affective meaning of stimulation. Revista de Psihologie, 1977, 23, 331-348.

Cohen, H. S. and Feldman, J. M. On the domain specificity of cognitive complexity: An alternative approach. Proceedings of the Annual Convention of the American Psychological Association, 1975.

Cooper, E. and Harper, R. Jr. The use of pilot ratings in the evaluation of aircraft handling qualities. AGARD, 567. Paris, April 1969.

Crockett, W. H. Cognitive complexity and impression formation. In. B. A. Maher (Ed.), Progress in experimental personality research (Vol. 2). New York: Academic Press, 1965.

Cronen, V. E. and LaFleur, G. Inoculation against persuasive attacks: A test of alternative explanations. Journal of Social Psychology, 1977, 102, 255-265.

Davis, C. S., Cook, D. A., Jennings, R. L., and Heck, E. J. Differential client attractiveness in a counseling analogue. Journal of Counseling Psychology, 1977, 24, 472-476.

Davis, E. G., Foster, G. D., Kirchner-Dean, E., and Swezey, R. W. An annotated bibliography of literature integrating organizational and systems theory. (SAI Report No. SAI-80-082-178) McLean, VA: Science Applications, Inc., 1980.

Delia, J. G. and Clark, R. A. Cognitive complexity, social perception, and the development of listener-adapted communication in six-, eight-, ten-, and twelve-year-old boys. Communication Monographs, 1977, 44, 326-345.

Domangue, B. B. Decoding effects of cognitive complexity, tolerance of ambiguity, and verbal-nonverbal inconsistency. Journal of Personality, 1978, 46, 519-535.

Driver, M. J. Conceptual structure and group processes in an internation simulation. Part One: The perception of simulated nations. Princeton, NJ: Princeton University and Educational Testing Service, ONR Tech. Rep. No. 9, NR 171-055 and AF Tech. Rep. AF 49(638)-742, and Res. Rep. NIMH Grant M 4186, 1962.

Driver, M. J. and Streufert, S. Group composition, input load and group information processing (Institute Paper, 142). Institute for Research in the Behavioral, Economic and Management Sciences, Purdue University, 1966.

Driver, M. J. and Struefert, S. Integrative complexity: An approach to individuals and groups as information processing systems. Administrative Science Quarterly, 1969, 14, 272-285.

Durand, R. M. Cognitive complexity, attitudinal affect, and dispersion in affect ratings for products. Journal of Social Psychology, 1979, 107, 209-212.

Durand, R. M. The effect of cognitive complexity on affect ratings in retail stores. Journal of Social Psychology, 1980, 110, 141-142.

Durand, R. M. and Lambert, Z. V. Cognitive differentiation and alienation of consumers. Perceptual and Motor Skills, 1979, 49, 99-108.

Einhorn, H. J. and Hogarth, R. M. Behavioral decision theory: Processes of judgment and choice. Annual Review of Psychology, 1981, 32, 53-88.

Elliott, R. Interrelationships among measures of field dependence ability and personality traits. Journal of Abnormal and Social Psychology, 1961, 63, 27-36.

Ellis, G. A. Subjective assessment. In Assessing Pilot Workload. AGARD, 233. NATO: Neuilly Surseine, France, February 1978, pp. 11-22.

Epting, F. R. and Wilkins, G. Comparison of cognitive structural measures for predicting person perception. Perceptual and Motor Skills, 1974, 38, 727-730.

Fiedler, F. E. Leader attitudes and group effectiveness. Urbana: University of Illinois Press, 1958.

Fromkin, H. L. and Streufert, S. Laboratory experimentation. In M. Dunnette (Ed.), Handbook of Organizational and Industrial Psychology. Chicago: Rand McNally, 1976.

Gerathewohl, S. J. Definition and measurement of perceptual and mental workload in aircrew and operators of Air Force weapon systems: A status report. In Higher Mental Functioning in Operational Environments. AGARD CP-181. Paris, April, 1976.

Goldstein, K. M. and Blackman, S. Cognitive style: Five approaches and relevant research. New York: Wiley, 1978.

Goodman, P. S. An empirical examination of Elliott Jaques' concept of time span. Human Relations, May 1967, 20(2), 155-170.

Hale, C. L. Cognitive complexity-simplicity as a determinant of communication effectiveness. Communication Monographs, 1980, 47, 304-311.

Harren, V. A., Kass, R. A., Tinsley, H. E., and Moreland, J. R. Influence of gender, sex-role attitudes, and cognitive complexity on gender-dominant career choices. Journal of Counseling Psychology, 1979, 26, 227-234.

Harvey, O. J. Some cognitive determinants of influencibility. Sociometry, 1964, 27, 208-221.

Harvey, O. J. (Ed.) Experience structure and adaptability. New York: Springer, 1966.

Harvey, O. J., Hunt, D. E., and Schroder, H. M. Conceptual systems and personality organization. New York: Wiley, 1961.

Hasse, R. F., Lee, D. Y., and Banks, D. L. Cognitive correlates of polychronicity. Perceptual and Motor Skills, August, 1979, 49(1), 271-282.

Heider, F. Attitudes and cognitive organization. Journal of Psychology, 1946, 21, 107-112.

Hendrick, H. W. Differences in group problem solving behavior and effectiveness as a function of abstractness. Journal of Applied Psychology, 1979, 64, 518-525.

Henke, A. H., Alden, D. G., and Levit, R. A. An analysis of human cognitive styles, Honeywell Document F0141, 2 volumes, 1972.

Hogan, H. W. and Mookherjee, H. N. Some developmental and racial dimensions of cognitive complexity. Social Behavior and Personality, 1980, 8, 85-89.

Holloway, E. L. and Wolleat, P. L. Relationship of counselor conceptual level to clinical hypothesis formation. Journal of Counseling Psychology, 1980, 27, 539-545.

Horike, K. Studies on person perception (1): The relationship of cognitive complexity to social interaction. Tohoku Psychologica, Folia, 1978, 37, 102-115.

Huber, O. The influence of some task variables on cognitive operations in an information-processing decision model. Acta Psychologica, August, 1980, 45(1-3), 187-196.

Hunt, D. E. Personality patterns in adolescent boys. Progress Report No. 7. Grant M 3517. Syracuse University, 1962.

Hunt, D. E. A conceptual systems change model and its application to education. In O. J. Harvey (Ed.), Experience, structure, and adaptability. New York: Springer, 1966.

Hussy, W. A study in operationalization and quantification of cognitive complexity. Archiv fur Psychologie, 1977, 129, 288-301.

Hussy, W. Analysis of the need for information during a modified prisoner's dilemma game. Zeitschrift fur Experimentelle und Angewandt Psychologie, 1979, 26, 561-572.

Hussy, W. and Scheller, R. Predictive value of cognitive variables in information processing. Archiv fur Psychologie, 1977, 129, 226-241.

Jacques, E., Gibson, R. O., and Isaac, D. J. Levels of abstraction in logic and human action. London: Heinemann, 1978.

Jacques, E. and Stamp, G. Level and type of capability in relation to executive organisation. First Year Technical Report. U.S. Army Procurement Agency, Europe, 1981.

Jacobs, T. O. Operationalization of Jacques' levels of complexity. Memorandum. U.S. Army Research Institute, PERI-ML, April, 1981.

Jaspars, J. M. Individual cognitive structures. Proceedings of the 17th International Congress of Psychology, Amsterdam, 1964.

Jones, A. P. and Butler, M. C. Influence of cognitive complexity on the dimensions underlying perceptions of the work environment. Motivation and Emotion, 1980, 4, 1-19.

Jones, D. P., Schipper, L. M., and Holzworth, R. J. Effects of amount of information on decision strategies. Journal of General Psychology. April, 1978, 98(2), 281-294.

Kelly, G. A. The psychology of personal constructs. Vol. 1: A theory of personality. New York: W. W. Norton, 1955.

Kostlin-Gloger, G. and Rottmair, I. Are reflective children more highly structured cognitively? Zeitschrift fur Entwicklungspsychologie und Padagogische Psychologie, 1979, 11, 12-15.

Kuusinen, J. and Nystedt, L. Individual versus provided constructs, cognitive complexity, and extremity of ratings in person perception. University of Stockholm: Reports from the Psychological Laboratories, 1972, No. 365.

Larson, J. R. Exploring the external validity of a subjectively weighted utility model of decision making. Organizational Behavior and Human Performance, December, 1980, 26(3), 293-304.

Laucht, M. and Krohne, H. W. Studies on the validity of the Role Construct Repertory Test as a measure of cognitive complexity. Archiv fur Psychologie, 1978, 130, 212-235.

Levi, A. and Tetlock, P. E. A cognitive analysis of Japan's 1941 decision for war. Journal of Conflict Resolution, 1980, 24, 195-211.

Lewin, K. Principles of topological psychology. New York: McGraw-Hill, 1936.

Linville, P. W. and Jones, E. E. Polarized appraisals of out-group members. Journal of Personality and Social Psychology, 1980, 38, 689-703.

Luchins, A. S. Primacy-recency in impression formation. In C. I. Hovland (Ed.), The order of presentation in persuasion. New Haven: Yale University Press, 1957, pp. 33-61.

Luchins, A. S. Definitiveness of impressions and primacy-recency in communications. Journal of Social Psychology, 1958, 48, 275-290.

MacCrimmon, K. R. and Taylor, R. N. Decision making and problem solving. In M. D. Dunnette (Ed.), Handbook of Industrial Psychology, Rand McNally College Publishing Co., Chicago, 1976.

Metcalfe, R. A. The validity, long-term reliability, generality, robustness, and inter-relatedness of selected Rep Grid indices of cognitive structure. Journal of Experimental Education, 1978, 47, 134-139.

Metcalfe, R. J. Own vs. provided constructs in a Rep test measure of cognitive complexity. Psychological Reports, 1974, 35, 1305-1306.

Mihevc, N. T. Information, valence, and cognitive complexity in the political domain. Journal of Psychology, 1978, 99, 163-177.

Milburn, T. W. and Billings, R. S. Decision-making perspectives from psychology: Dealing with risk and uncertainty. American Behavioral Scientist, September/October, 1976, 20(1), 111-126.

Mitchell, T. R. The construct validity of three dimensions of leadership research. Journal of Social Psychology, 1970, 80, 89-94.

Mizerski, R. W. Causal complexity: A measure of consumer causal attribution. Journal of Marketing Research, 1978, 15, 220-228.

Morris, W. T. Intuition and relevance. Management Science, 1967, 14(4), B-157-B-165.

Neimeyer, G. J. and Banikiotes, P. G. Flexibility of disclosure and measures of cognitive integration and differentiation. Perceptual and Motor Skills, 1980, 50, 907-910.

Nidorf, L. J. and Argabrite, A. H. Cognitive complexity and the tendency to make extreme judgments. Perceptual and Motor Skills, 1970, 31, 478.

O'Donnell, R. D. Secondary task assessment of cognitive workload in alternative cockpit configurations. Higher Mental Functioning in Operational Environments. AGARD Conf. Prepring No. 181, London, 1975.

Ohbuchi, K. and Horike, K. On consistency of cognitive complexity between different grids. Japanese Psychological Research, 1978, 20, 177-182.

O'Keefe, D. J. and Brady, R. M. Cognitive complexity and the effects of thought on attitude change. Social Behavior and Personality, 1980, 8, 49-56.

O'Keefe, B. J. and Delia, J. G. Construct comprehensiveness and cognitive complexity. Perceptual and Motor Skills, 1978, 46, 548-550.

O'Keefe, B. J., Delia, J. G., and O'Keefe, D. J. Construct individuality, cognitive complexity, and the formation and remembering of interpersonal impressions. Social Behavior and Personality, 1977, 5, 229-240.

Olshavsky, R. W. Task complexity and contingent processing in decision making: A replication and extension. Organizational Behavior and Human Performance, December, 1979 24(3), 300-316.

Park, C. W. A seven-point scale and a decision-maker's simplifying choice strategy: An operationalized satisficing-plus model. Organizational Behavior and Human Performance, April, 1978, 21(2), 252-271.

Park, C. W. A conflict resolution choice model. Journal of Consumer Research, September, 1978 5(2), 124-137.

Pask, G. A cybernetic experimental method and its underlying philosophy. International Journal of Man-Machine Studies, 1971, 3, 279.

Payne, J. W. Task complexity and contingent processing in decision making: An information search and protocol analysis. Organizational Behavior and Human Performance, August, 1976, 16(2), 366-387.

Payne, J. W. and Braunstein, M. L. Risky choice: An examination of information acquisition behavior. Memory and Cognition, September, 1978, 6(5), 554-561.

Perrault, W. D. and Russ, F. A. Comparing multiattribute evaluation process models. Behavioral Science, November, 1977, 22(6), 423-431.

Peterson, C. and Scott, W. A. Generality and topic specificity of cognitive styles. Unpublished manuscript, University of Colorado, 1974.

Poole, M. E. Exploration of relationship inherent in linguistic, cognitive, and verbal processing domains. Psychological Reports, 1978, 43, 639-647.

Porter, C. A. and Suedfeld, P. Integrative complexity in the corresponding of literary figures: Effects of personal and societal stress. Journal of Personality and Social Psychology, 1981, 40, 321-330.

Posner, M. I. and Mitchell, R. Chronometric analysis of classification. Psychological Review, 1967, 74, 392-409.

Pyron, B. A factor analytic study of simplicity complexity of social ordering. Perceptual and Motor Skills, 1966, 22, 259-272.

Quinn, E. Creativity and cognitive complexity. Social Behavior and Personality, 1980, 8, 213-215.

Raphael, D., Moss, S. W., and Rosser, M. E. Evidence concerning the construct validity of conceptual level as a personality variable. Canadian Journal of Behavioural Science, 1979, 11, 327-339.

Rotton, J., Olszewski, D., Charleton, M., and Soler, E. Loud speech, conglomerate noise, and behavioral aftereffects. Journal of Applied Psychology, 1978, 63, 360-365.

Rouse, W. B. and Rouse, S. H. Measures of complexity of fault diagnosis tasks. IEEE Transactions on Systems, Man, and Cybernetics, 1979, SMC-9, 720-727.

Rowbottom, R. Social analysis: A collaborative method of gaining usable scientific knowledge of social institutions. London: Heinemann, 1977.

Rule, B. G. and Hewitt, D. Factor structure of anti-Semitism, self-concept and cognitive structure. Personality, 1970, 1, 319-332.

Sauser, W. I. and Pond, S. B. Effects of rater training and participation on cognitive complexity: An exploration of Schneier's cognitive reinterpretation. Personnel Psychology, 1981, 34, 563-577.

Schneider, J. F., Kohler, A., and Wachter, H. Conservatism and cognitive complexity. Psychological Reports, 1979, 44, 981-982.

Schneier, C. E. The contingency model of leadership: An extension to emergent leadership and leader's sex. Organizational Behavior and Human Performance, 1978, 21, 220-239.

Schneier, C. E. Measuring cognitive complexity: Developing reliability, validity, and norm tables for a personality instrument. Educational and Psychological Measurement, 1979, 39, 599-612.

Schroder, H. M. The measurement and development of information processing systems. Management Information Systems, 1971, 14, 811-829.

Schroder, H. M., Driver, M. J., and Streufert, S. Human information processing. New York: Holt, Rinehart, and Winston, 1967.

Schroder, H. M. and Streufert, S. The measurement of four systems of personality structure varying in level of abstractness: Sentence completion method (ONR Tech. Rep. No. 11). Princeton, NJ: Princeton University, 1962.

Schroder, H. M. and Suedfeld, P. (Eds.) Personality theory and information processing. New York: Ronald Press, 1971.

Scott, W. A. Cognitive consistency, response reinforcement and attitude change. Sociometry, 1959, 22, 219-229.

Scott, W. A. Cognitive complexity and cognitive flexibility. Sociometry, 1962, 25, 405-414. (a)

Scott, W. A. Cognitive consistency, response reinforcement and attitude change. In N. F. Washburne (Ed.), Decisions, values and groups. New York: Pergamon Press, 1962. (b)

Scott, W. A. Cognitive structure and social structure: Some concepts and relationships. In N. F. Washburne (Ed.), Decisions, values and groups. New York: Pergamon Press, 1962. (c)

Scott, W. A. Conceptualizing and measuring structural properties of cognition. In O. J. Harvey (Ed.), Motivation and social interaction. New York: Ronald Press, 1963.

Scott, W. A. Brief report: Measures of cognitive structure. Multivariate Behavioral Research, 1966, 1, 391-395.

Scott, W. A. Structure of natural cognitions. Journal of Personality and Social Psychology, 1969, 12, 261-278.

Scott, W. A. Varieties of cognitive integration. Journal of Personality and Social Psychology, 1974, 30, 563-578.

Scott, W. A., Osgood, D. W., and Peterson, C. Cognitive structure: Theory and measurement of individual differences. Washington, D.C.: V. H. Winston and Sons, 1979.

Shalit, B. Structural ambiguity and limits to coping. Journal of Human Stress, 1977, 3, 32-45.

Sidanius, J. Cognitive functioning and socio-politico ideology: An exploratory study. Perceptual and Motor Skills, 1978, 46, 515-530.

Sieber, J. E. and Lanzetta, J. T. Conflict and conceptual structure as determinants of decision making behavior. Journal of Personality, 1964, 32, 622-641.

Smith, A. I. and Evans, D. R. Construct structure associated with alcohol dependent behavior in males. Psychological Reports, 1980, 47, 87-99.

Smith, S. and Leach, C. A hierarchical measure of cognitive complexity. British Journal of Psychology, 1972, 63, 561-568.

Spyker, D. A., Stackhouse, S. P., Khalafalla, A. S., and McLane, R. C. Development of techniques for measuring pilot workload. National Aeronautics and Space Administration Report No. NASA-CR-1888. November, 1971.

Stabell, C. B. Integrative complexity of information environment perception and information use: An empirical investigation. Organizational Behavior and Human Performance, 1978, 22, 116-142.

Stager, P. Conceptual level as a composition variable in small group decision making. Journal of Personality and Social Psychology, 1967, 5, 152-161.

Starbird, D. H. and Biller, H. B. An exploratory study of the interaction of cognitive complexity dogmatism and repression-sensitization among college students. Journal of Genetics Psychology, 1966, 128, 227-232.

Sternberg, R. J. Testing and cognitive psychology. American Psychologist, October, 1981 36(10), 1181-1189.

Sternberg, S. Memory-scanning: Mental processes revealed by reaction-time experiments. American Scientist, 1969, 4, 421-457.

Stewin, L. Integrative complexity: Structure and correlates. Alberta Journal of Educational Research, 1976, 22, 226-236.

Stogdill, R. M. New leader behavior description subscales. Journal of Psychology, 1962, 54, 259-569.

Streufert, S. Complexity and complex decision making: Convergences between differentiation and integration approaches to the prediction of task performance. Journal of Experimental Social Psychology, 1970, 6, 494-509.

Streufert, S., personal communication, 1972.

Streufert, S. The human component in the decision-making situation. In B. King, S. Streufert, and F. E. Fiedler (Eds.), Managerial control and organizational democracy. Washington, D.C.: V. H. Winston and Sons and John Wiley, 1978, 215-230.

Streufert, S., Clardy, M. A., Driver, M. J., Karlins, M., Schroder, H. M., and Suedfeld, P. A tactical game for the analysis of complex decision making in individuals and groups. Psychological Reports, 1965, 17, 723-729.

Streufert, S. and Driver, M. J. Conceptual structure, information load and perceptual complexity. Psychonomic Science, 1965, 3, 249-250.

Streufert, S. and Driver, M. J. Impression formation as a measure of the complexity of conceptual structure. Educational and Psychological Measurement, 1967, 27, 1025-1039.

Streufert, S., Nogami, G. Y., and Streufert, S. C. Crowding and incongruity adaptation. In I. G. Sarason and C. D. Spielberger (Eds.), Stress and anxiety, Vol. 7. Washington, D.C.: Hemisphere Publishing Corporation, 1980, 185-202.

Streufert, S. and Schroder, H. M. The measurement of four systems of personality structure varying in the level of abstractness: Impression formation method (ONR Tech. Rep.). Princeton, NJ: Princeton University, 1963.

Streufert, S. and Schroder, H. M. Conceptual structure, environmental complexity and task performance. Journal of Experimental Research in Personality, 1965, 1, 132-137.

Streufert, S. and Streufert, S. C. Behavior in the complex environment. Washington, D. C.: V. H. Winston and Sons and John Wiley, 1978.

Streufert, S. and Streufert, S. C. Stress and information search in complex decision making: Effects of load and time urgency. ONR Technical Report No. 4, 1981.

Streufert, S. and Streufert, S. C. Effects of load stressors on performance in a multidimensional visual motor task. Hershey, PA: Pennsylvania State University Technical Report to the Office of Naval Research No. 6, 1982.

Streufert, S., Streufert, S. C., Dembroski, T. M., and MacDougall, J. M. Complexity, coronary prone behavior and physiological response. In D. J. Oborne, M. M. Gruneberg, and J. R. Eiser (Eds.), Research in psychology and medicine. Vol. 1. London: Academic Press, 1979, 206-218.

Streufert, S., Streufert, S. C., and Gorson, D. M. Time urgency and coronary prone behavior: The effectiveness of a behavior pattern. Basic and Applied Social Psychology, 1981, 2, 161-174.

Streufert, S. and Swezey, R. W. Organizational simulation: Theoretical aspects of test bed design. (SAI Report No. SAI-80-010-178) McLean, VA: Science Applications, Inc., 1980.

Strub, M. H. and Levit, R. A. Computer compatibility with decision style: Eddies in a bit stream. Proceedings of the Human Factors Society, 1974, pp. 46-49.

Suedfeld, P. and Tetlock, P. E. Integrative complexity of communications in international crisis. Journal of Conflict Resolution, 1977, 21, 169-184.

Suedfeld, P., Tomkins, S. S., and Tucker, W. H. On relations among perceptual and cognitive measures of information processing. Perception and Psychophysics, 1969, 6, 45-46.

Svenson, O. Process descriptions of decision making. Organizational Behavior and Human Performance, February, 1979, 23(1), 86-112.

Swezey, R. W., Davis, E. G., Baudhuin, E. S., Streufert, S., and Evans, R. A. Organizational and systems theories: An integrated review. (SAI Report No. SAI-80-113-178). McLean, VA: Science Applications, Inc., 1980.

Toda, M. The decision process: A perspective. International Journal of General Systems, 1976, 3, 79-88.

Tripodi, T. and Bieri, J. Cognitive complexity as a function of own and provided constructs. Psychological Reports, 1963, 13, 26.

Tuckman, B. W. Integrative complexity: Its measurement and relation to creativity. Educational and Psychological Measurement, 1966, 26, 369-382. (a)

Tuckman, B. W. Interpersonal probing and revealing and systems of integrative complexity. Journal of Personality and Social Psychology, 1966, 3, 655-664. (b)

Vace, N. A. and Burt, M. A. Assessment of cognitive complexity with emotionally handicapped children. Behavioral Disorders, 1980, 6, 26-31.

Vannoy, J. S. Generality of cognitive complexity-simplicity as a personality construct. Journal of Personality and Social Psychology, 1965, 2, 385-396.

Vecchio, R. A test of the cognitive complexity interpretation of the least perferred co-worker scale. Educational and Psychological Measurement, 1979, 39, 523-526.

Vetter, M. Ego development and cognitive complexity. Zeitschrift fur Entwicklungspsychologie und Padagogische Psychologie, 1980, 12, 126-143.

Von Eye, A. and Hussy, W. On the contribution of variables of cognitive complexity to the identification of risk groups in traffic. Schweizerische Zeitschrift fur Psychologie und ihre Anwendungen, 1979, 38, 58-70.

Watkins, P. R. Perceived information structure: Implications for decision support system design. Decision Sciences, 1982, 13, 38-59.

Weiss, H. M. and Adler, S. Cognitive complexity and the structure of implicit leadership theories. Journal of Applied Psychology, 1981, 66, 69-78.

Werner, H. Comparative psychology of mental development. New York: International Universities Press, 1957.

White, B. J. and Harvey, O. J. Effects of personality and own stand on judgment and production of statements about a central issue. Journal of Experimental Social Psychology, 1965, 1, 334-347.

White, C. M. Cognitive complexity and completion of social structures. Social Behavior and Personality, 1977, 5, 305-310.

Witkin, H. A., Goodenough, D. R., and Oltman, P. K. Psychological differentiation: Current status. Journal of Personality and Social Psychology, 1979, Vol. 37, No. 7, 1127-1145.

Wojciszke, B. Affective factors in organization of cognitive structures in the context of interpersonal perception. Polish Psychological Bulletin, 1979, 10, 3-13.

Wolfe, J. and Chacko, T. I. Cognitive structures of business game players. Simulation and Games, 1980, 11, 461-476.

Wolfe, R., Egleston, R., and Powers, J. Conceptual structure and conceptual tempo. Perceptual and Motor Skills, 1972, 35, 331-337.

Wright, W. F. Properties of judgment models in a financial setting. Organizational Behavior and Human Performance, February, 1979, 23(1), 73-85.

Wyer, R. S. Assessment and correlates of cognitive differentiation and integration. Journal of Personality, 1964, 32, 395-509.

Zajonc, R. B. The process of cognitive tuning in communication. Journal of Abnormal and Social Psychology, 1960, 61, 159-167.

Zalot, G. and Adams, W. J. Cognitive complexity in the perception of neighbors. Social Behavior and Personality, 1977, 5, 281-283.